The University of Zambia

in association with

The Zambia Centre for Accountancy Studies

BACHELOR OF ARTS IN ECONOMICS AND FINANCE

BEF231 MICROECONOMICS

MODULE

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1.0 INTRODUCTION

WELCOME to Microeconomics course. It's with full understanding that you have done introduction to economics and quantitative methods in your first year and you have basic understanding of what microeconomics is all about.

A quick run through the course; In part A, we analyse consumer choice, how to go from preferences to utility, to optimal choice and then demand functions. In part B individuals will make a choice on how many factors of production they will supply to the firms. In part C, we model the agent's behaviour in situations involving risk, and analyse insurance problems. In part D, we describe the production technology, structure of costs and principles of profit maximisation by firms. In part E, we look at the market structure and later look at the simultaneous decision making of two commodities to be produced or consumed in an Edgeworth box. In part G we provide an exposition of the basic tools of game theory and of the problem of oligopolistic competition. Next, we turn to the problem of asymmetric information and analyse the problems of adverse selection and moral hazard.

I would therefore strongly advise against picking a single textbook and concentrating one's effort on it. Instead, you should conduct your study along the lines and recommendations of this subject guide. In it you will find a well-focused organisation of the subject which will highlight those things which are deemed to be important. You will find, on each topic, references to readings from a set of textbooks which will help you understand each topic through the use of different methods of exposition.

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1.1 MODULE AIM

To enable students analyse the way in which the market system functions as a mechanism for coordinating the independent choices of individual economic agents.

1.2 OBJECTIVES

By the end of the course, students should be able to:

- Discuss the basic theory of optimization by economic agents;
- Apply mathematical methods to optimize choices and decisions by consumers and firms;
- Analyse strategic interaction as well as interaction under asymmetric information;
- Discuss the role of economic policies as stools to improve efficiency in the presence of market failures
- Analyse the interdependence problems of game theory.

1.3 ASSESSMENT DETAILS

ASSESSMENT

Continuous assessment	**50%**
2 tests of equal weight	30%
2 assignments of equal weight	20%
Final examination	**50%**
TOTAL	**<u>100%</u>**

1.4 READINGS

Prescribed Reading

1. Morgan, W., M.L. Katz and H.S. Rosen (2009) *Microeconomics*. (2nd edition). Berkshire: McGraw-Hill.

2. Varian, H.R. (2010) *Intermediate Microeconomics* (8th edition). New York: W.W Norton & company.

3. Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing.

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Recommended Readings

1. Nicholson, W. and Snyder, C.M (2010) *Theory and application of intermediate Microeconomics* (11th edition). Australia: South Western College Publishing.
2. Perloff, J.M. (2007) *Microeconomics* (4th edition). Boston: Pearson Addison-Wesley.
3. Mankiw, G.N. (2008) *principles of microeconomics; a guide tour* (5th edition). Australia: south western cengage learning.
4. Bernheim, B.D and Whiston, M.D (2008) *Microeconomic*s. Boston: McGraw-Hill Irwin.
5. Nicholson, W. and Snyder, C.M (2010) *Theory and application of intermediate Microeconomics* (11th edition). Australia: South Western College Publishing.
6. Perloff, J.M. (2007) *Microeconomics* (4th edition). Boston: Pearson Addison-Wesley.
7. Mankiw, G.N. (2008) *principles of microeconomics; a guide tour* (5th edition). Australia: south western cengage learning.
8. Bernheim, B.D and Whiston, M.D (2008) *Microeconomic*s. Boston: McGraw-Hill Irwin.

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1.5 TIME FRAME

The total time required for the student to complete the;

- Exercises; for each exercise, you need to take a minimum of 45minutes, meaning you need a total of 10 hours.

- In total the module should take you a minimum of 48hours to complete.

1.6 STUDY SKILLS

For you to be able successfully complete this module, you will need do the following:

- Set aside 4 hours of study per week over the duration of the semester.

- Read through each module.
- Break down your study in syllabus coverage, revision and examination practice. Imagining a 15 week study programme, you can allocate 5 weeks each. They are very important to passing the examination.
- Complete the activities and assignments for each module as a way of practicing and reinforcing the knowledge.

1.7 NEED HELP?

If you need help on the module, please use the following contacts:

Course Tutor

Email: information@zcas.edu.zm

Zambia Centre for Accountancy Studies (ZCAS)

Dedan Kimathi Road, P O Box 35243, Lusaka, Zambia

Tel: +260 1 232093/5, Fax: +260 1 222542

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2.0 UNIT ONE: CONSUMER CHOICE THEORY

2.1 INTRODUCTION

In this unit we look at how individuals make decision on what bundles to consume based on their preference. If people can tell us the order of their preference between two bundles then it can be modeled so that predictions can be made about how people behave. It is from these preferences that we will get to know the demand functions of individuals.

2.2 AIM

The aim of this unit is to ensure that the student can mathematically model consumer optimization and demand functions.

2.3 OBJECTIVES

At the end of this unit you should be able to do the following

- Use the langrage function to maximize utility with the given income level or minimize expenditure with the given utility
- Compute the comparative statics of a price change on the optimal consumption bundle.
- Derive and distinguish the Marshallian and Hicksian demand function
- Calculate the income and substitution effect of a price change.

2.4 TIME REQUIRED

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Minimum amount of time on the unit is 2 hours

2.5 REFLECTION

you are in a supermarket shopping, you are trying to make a decision between two commodities; what determines your choice between price of the commodity and satisfaction you get from it?

2.6. READINGS

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing

Morgan, W., M.L. Katz and H.S. Rosen (2009) *Microeconomics*. (2nd edition). Berkshire: McGraw-Hill. Chapter 2,3 and 4

Varian, H.R. (2010) *Intermediate Microeconomics* (8th edition). New York: W.W Norton & company.

2.7 OVERVIEW

In introduction to microeconomics we learnt how consumers make choices on goods they want to consume and buy . We looked at indifference curves, utility and demand functions. We recap on the subject matter

Tastes and preferences; if you are faced with two or more bundles of two commodities (e.g. books and potatoes) and you are asked to choose between them, you would have to tell us which one you would prefer over the other. Meanwhile, a bundle is a combination of two commodities. For example bundle A can contain 3books and 2potatoes, while bundle B can contain 4books and 1 potato. So you could be asked to choose between bundle A or B.

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Therefore, the consumer can determine that one bundle is strictly better than the other or decide that s/he is indifferent between the two bundles.

We shall use symbols like $\succ$ to mean that one bundle is strictly preferred to another, so that $(x_1, x_2) \succ (y_1, y_2)$ implying that the consumer strictly prefers (x_1, x_2) to (y_1, y_2). The consumer wants bundle x rather than the y bundle.

If the consumer is indifferent between two bundles of goods we use the symbol~ and write $(x_1, x_2) \sim (y_1, y_2)$. Indifference means that consumers are just as satisfied consuming bundle x as she would consume bundle y.

If the consumer prefers or is indifferent between the two bundles we say that she weakly prefers (x_1, x_2) to (y_1, y_2) and we write $(x_1, x_2) \succeq (y_1, y_2)$.

We make some assumptions about how the preference relations work. These assumption are fundamental and are called axioms of consumer theory.

AXIOMS OF CONSUMER CHOICE

- Completeness. If A and B are any two bundles, the individual can always specify exactly one of the following three possibilities:

1. ''A is preferred to B,''
2. ''B is preferred to A,'' or
3. ''A and B are equally attractive.''

Consequently, people are assumed not to be paralyzed by indecision: They completely understand and can always make up their minds about the desirability of any two alternatives. The assumption also rules out the possibility that an individual can report both that A is preferred to B and that B is preferred to A.

- Transitivity. If an individual reports that ''A is preferred to B'' and ''B is preferred to C,'' then he or she must also report that ''A is preferred to C.''

This assumption states that the individual's choices are internally consistent. A person's choices are indeed transitive.

- Continuity. If an individual reports ''A is preferred to B,'' then situations suitably ''close to'' A must also be preferred to B.

- Non-satiation for all feasible quantities of commodities, the consumer is never satiated. A bundle with more of either commodity is preferred to a bundle with less.

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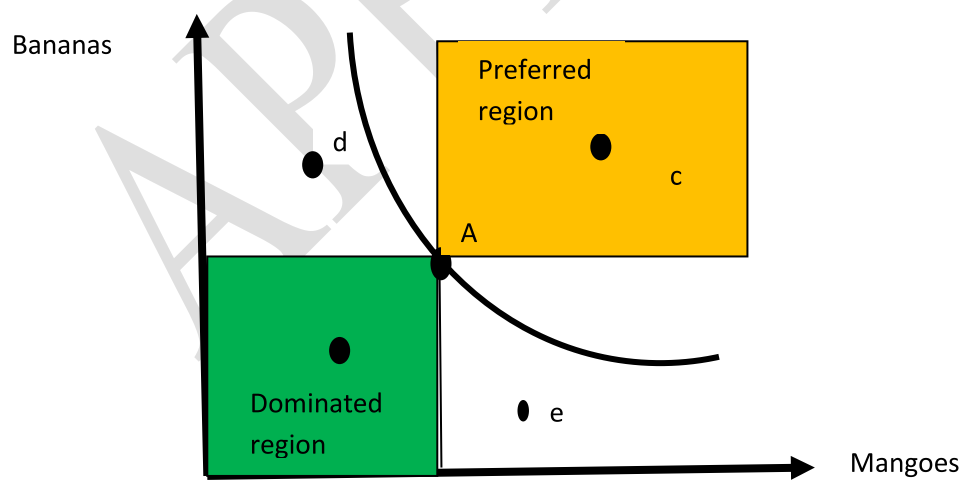
Indifference curves and marginal rate of substitution

The preferences that satisfy the axioms can be expressed in an indifference curve. The graph below can be explained as follows

- Bundles in the region above point A have more of both mangoes and bananas therefore they are preferred more to those in region below A
- The bundles in the region below A have less of both commodities, therefore they are less preferred to the bundles in the white region and the region above A
- The bundles in the white region have more of one commodity. Its either it has more of bananas and less of mangoes or more mangoes and less bananas. These bundles are indifferent to each other but definitely preferred to the ones in the region below A.

The bold line drawn in the white region that sets a boundary between the less preferred and the most preferred is called an **indifference curve.** An indifference curve is a locus of points that shows the combination of two commodities that give the same level of satisfaction. A Movement from one point on the indifference curve to another, means sacrificing the consumption of one commodity in order to get more of the other commodity. The slope of the indifference shows the willingness to substitute a commodity for another commodity. This is referred to the **marginal rate of substitution.**



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Given a utility function **;**

$Utility = U(x_1, x_2,,,,,,, x_n)$ that shows that utility is a function of all the goods that we consume. We give a two good utility function

$Utility = U(X, Y)$

The slope of the indifference curve with y on the y-axis and x on the x- axis is

$$\frac{dy}{dx} = -\frac{MU_x}{MU_y}$$

$$MRS_{xy} = \frac{MU_x}{MU_y}$$

Derivation

We will do a total derivative of the utility function

$Utility = U(X, Y)$

$$dU = \frac{\partial u}{\partial x} dX + \frac{\partial u}{\partial y} dY$$

The first order condition of optimization equates the first derivative to zero, therefore

$$dU = 0$$

$$dU = \frac{\partial u}{\partial x} dX + \frac{\partial u}{\partial y} dY = 0$$

$$\frac{\partial u}{\partial x} dX = \frac{\partial u}{\partial y} dY$$

$$\frac{\partial u}{\partial x} = \frac{\partial u}{\partial y} \frac{dY}{dX}$$

$$\frac{dy}{dx} = \frac{\partial U}{\partial x} \div \frac{\partial U}{\partial y}$$

$$\frac{dy}{dx} = \frac{MU_x}{MU_y}$$

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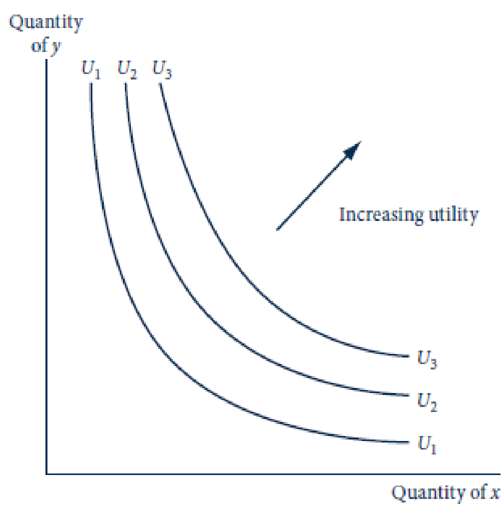
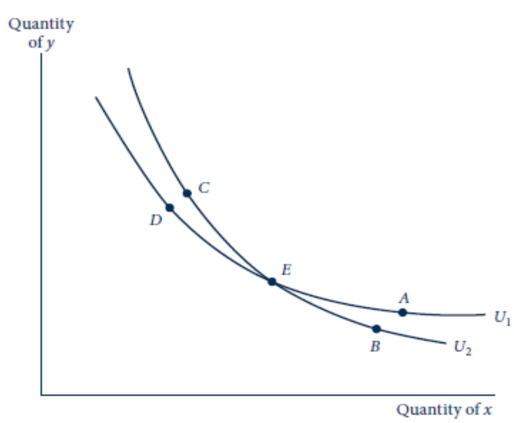
$$MRS_{xy} = \frac{MU_x}{MU_y}$$

Given a map of indifference curve, higher indifference curves show higher utility and lower indifference curves show lower utility.



source; Nicholson &snynder,2012

Indifference curves are not supposed to cross. From the figure below, bundle C is indifferent to bundle E and bundle D is indifferent to bundle E, from transitivity bundle D should be indifferent to bundle C, however, bundle C is preferred to bundle D. this is inconsistent with rational preferences.



source; Nicholson &snynder,2012

Indifference curves are convex to the origin. Given two coordinates (X_1, Y_1) and (X_2, Y_2), any linear combination $(X_1\lambda + (1-\lambda)X_2), (Y_1\lambda + (1-\lambda)Y_2)$ for whatever value of λ, should lie inside

the curve on bundles that are preferred. From the figure below, panel (a) shows convexity of an indifference curve and diminishing marginal rate of substitution is possible. Panel (b) is not convex because the linear combination of the two points does not lie in the preferred region, thus diminishing MRS cannot apply.

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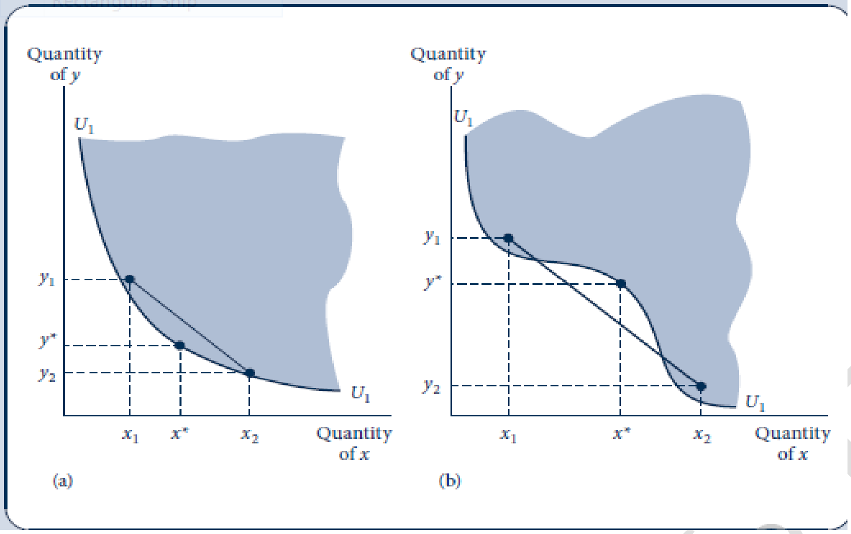
In (a) the indifference curve is *convex* (any line joining two points above U_1 is also above U_1). In (b) this is not the case, and the curve shown here does not everywhere have a diminishing *MRS*.



source; Nicholson &snynder,2012

Example

An individual has a utiliy function $U = \sqrt{xy}$. Suppose utility is 10 draw the indifference curve that shows combinations of x and y yielding the same utility. And show that its convex.

$$U = \sqrt{xy}$$
$$10^2 = \left(\sqrt{xy}\right)^2$$
$$100 = xy$$
$$y = \frac{100}{x}$$

$$MRS_{xy} = \frac{dy}{dx}$$
$$\frac{dy}{dx} = -\left(-\frac{100}{x^2}\right)$$
$$MRS_{xy} = \frac{100}{x^2}$$

MRS is decreasing as x increases. This shows that diminishing MRS is possible therefore it is convex.

SUBSTITUTES AND COMPLEMENTS

Indifference curves for perfect substitutes are straight lines because you give up equal amounts of good y to gain and equal amount of good X. whereas indifference curves for goods that are prefect complements are L shaped. This is because perfect complements are consumed in a given ratio. An increase in one good does not increase utility but increasing both goods puts you on a higher indifference curve

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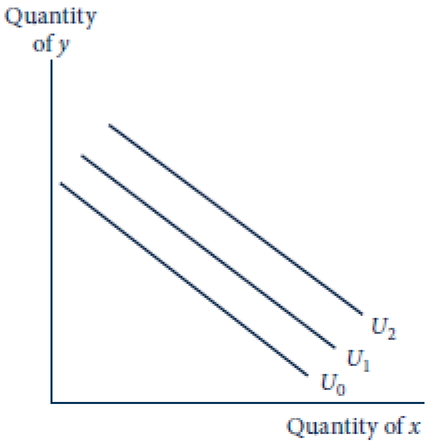
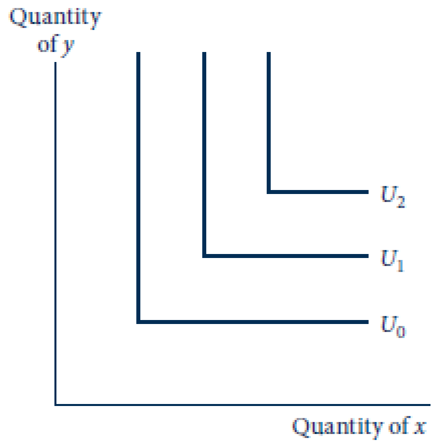


(b) Perfect substitutes



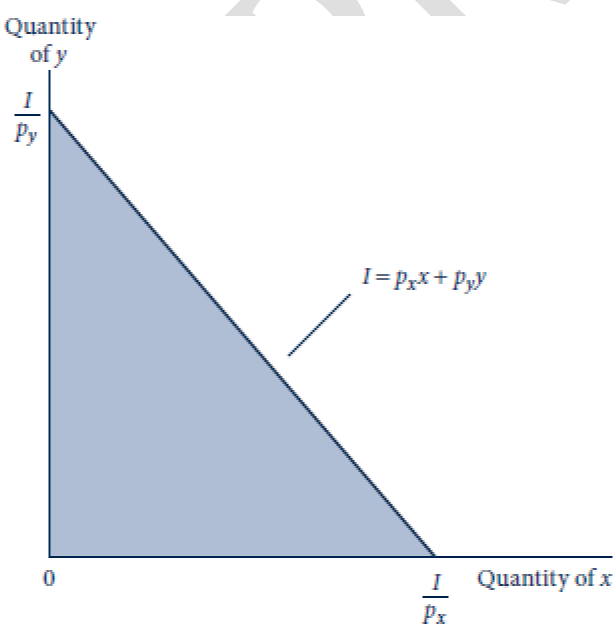
(c) Perfect complements

Perfect substitutes take the functional form form $Utility = \alpha x + \beta y$ where β and α are constants. Perfect complements take the functional form $Utility = \min(\alpha x, \beta y)$

BUDGET CONSTRAINT

Given and income of I and prices of the comodities P_x and P_y, an individual can decide how much of each good to consume. The budget constraint is given by

$$xp_x + yp_y \leq I$$



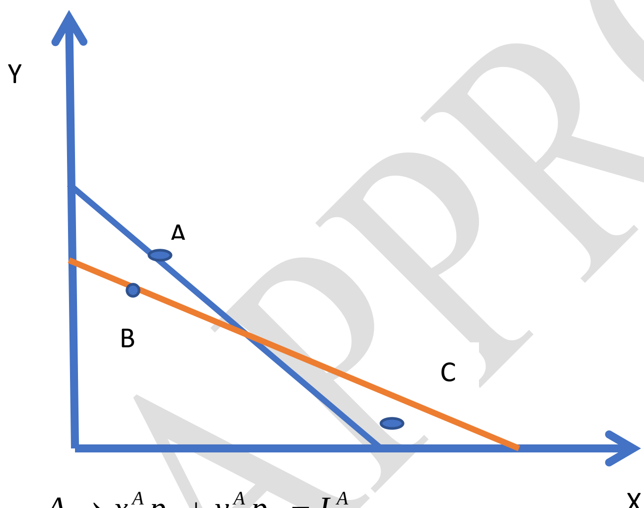
If all income is consumed, there is an equality in the equation and we have a straight line. All bundles in the region below the budget line means not all our income is spent. Above the budget line are unattainable bundles because they are expensive and unaffordable.

the slope of the budget line

$$\frac{dy}{dx} = -\frac{p_x}{p_y}$$

REVEALED PREFERENCE AND BUDGET CONSTRAINT

Revealed preference; given any two bundles(X_1,Y_1) and (X_2,Y_2) that are both affordable and available, if a consumer picks bundle(X_1,Y_1) , then they have revealed their prefervence over that bundle than the other. In any situation where both bundles are affordable and available bundle (X_1,Y_1) should always be picked. If bundle (X_2,Y_2)is picked then the first bundle should not be affordable nor available.



$$A \rightarrow x^A p_x + y^A p_y = I^A$$
$$B \rightarrow x^B p_x + y^B p_y = I^B$$
$$x^A p_x + y^A p_y \rangle x^B p_x + y^B p_y$$

Point A is directly revealed prefered over point B.point B is revelead prefered over point C. thus, point A is indirectly revaled preferd over point C.

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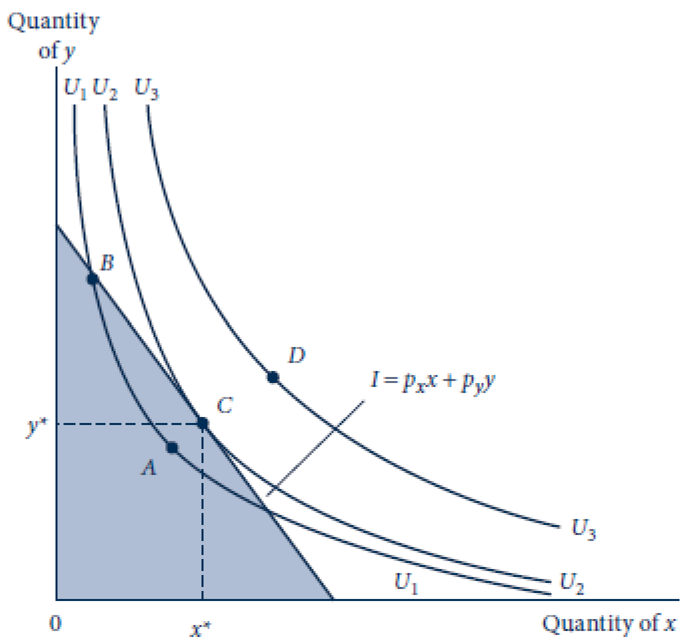
Weak axion of revealed prefernce states that if (X_1,Y_1) is directly revealed prefered to (X_2,Y_2), and the two bundles are not the same, then it cannot happen that (X_2,Y_2) is directly prefered prefered to (X_1,Y_1)

Strong axiom of revealed preference states that if (X_1,Y_1) is revealed prefered to (X_2,Y_2)either directly or indirectly, and the two bundles are not the same, then it cannot happen that (X_2,Y_2) is prefered to (X_1,Y_1) either directly or indirectly.

UTILITY MAXIMISATION

The consumer choses a bundle on the budget line that give the highest level of satisfaction. This is where the budget line is tangent to the indifference curve.



At this point it means that MRS ie equal to the slope of the budget line.

$$MRS_{XY} = -\frac{P_X}{P_Y}$$

DERIVATION

Max $Utility = U(xy)$ st $xp_x + yp_y \leq I$

We use a langrage equation

$$\ell = U(xy) + \lambda(I - xp_x - yp_y)$$

$$\frac{d\ell}{dx} = \frac{dU}{dx} - \lambda p_x = 0$$

$$\frac{d\ell}{dy} = \frac{dU}{dy} - \lambda p_y = 0$$

$$\frac{d\ell}{d\lambda} = I - xp_x - yp_y = 0$$

Make λ the subject of the formula

$$\lambda = \frac{dU}{dx} \times \frac{1}{p_x} \qquad \frac{dU}{dx} \times \frac{1}{p_x} = \frac{dU}{dY} \times \frac{1}{py}$$

$$\lambda = \frac{dU}{dy} \times \frac{1}{py} \qquad \frac{dU}{dx} \div \frac{dU}{dy} = -\frac{p_x}{p_y}$$

Example

Suppose a consumer has utility function $U = X^{\alpha} Y^{\beta}$ where α=β=0.5 and has a budget constraint $xp_x + yp_y = I$. Find the optimal bundle that maximises utility.

$$\ell = X^{\alpha} Y^{\beta} + \lambda(I - XP_X + YP_Y)$$

$$\frac{d\ell}{dx} = \alpha X^{\alpha-1} Y^{\beta} - \lambda p_x = 0$$

$$\frac{d\ell}{dy} = \beta X^{\alpha} Y^{\beta-1} - \lambda p_y = 0$$

$$\frac{d\ell}{d\lambda} = I - xp_x - yp_y = 0$$

$$\lambda = \alpha X^{\alpha-1} Y^{\beta} \times \frac{1}{p_x}$$

$$\lambda = \beta X^{\alpha} Y^{\beta-1} \times \frac{1}{py}$$

$$\alpha X^{\alpha-1} Y^{\beta} \times \frac{1}{p_x} = \beta X^{\alpha} Y^{\beta-1} \times \frac{1}{py}$$

$$\frac{\alpha X^{\alpha-1} Y^{\beta}}{\beta X^{\alpha} Y^{\beta-1}} = \frac{P_x}{P_y}$$

$$\frac{\alpha Y}{\beta X} = \frac{P_x}{P_y}$$

The value of λ implies that a small change in income will increase utility by $\alpha X^{\alpha-1} Y^{\beta} \times \frac{1}{p_x}$

To solve for the bundles of x and y, we make YP_y the subject of the formula and replace in the constraint equation

$$\frac{\alpha Y}{\beta X} = \frac{P_x}{P_y}$$

$$YP_y = \frac{\beta XP_x}{\alpha}$$
$$I - XP_x - YP_y = 0$$
$$XP_x + \frac{\beta XP_x}{\alpha} = I$$
$$\frac{\alpha XP_x + \beta XP_x}{\alpha} = I$$
$$XP_x(\alpha + \beta) = \alpha I$$
$$X^* = \frac{\alpha I}{(\alpha + \beta)P_x} = \frac{I}{2P_x}$$

$$YP_y = \frac{\beta XP_x}{\alpha}$$
$$YP_y = \frac{\beta P_x}{\alpha} \times \frac{\alpha I}{(\alpha + \beta)P_x}$$
$$Y^* = \frac{\beta I}{(\alpha + \beta)P_y} = \frac{I}{2P_y}$$

Replacing X^* and Y^* in the utility function gives us an indirect utility function

$$V = \left(\frac{I}{2P_x}\right)^{\alpha}\left(\frac{I}{2P_y}\right)^{\beta} = \frac{I}{2P_x^{0.5}P_y^{0.5}}$$

Expenditure minimisation

We are minimising expenditure subject to a given level of utility.

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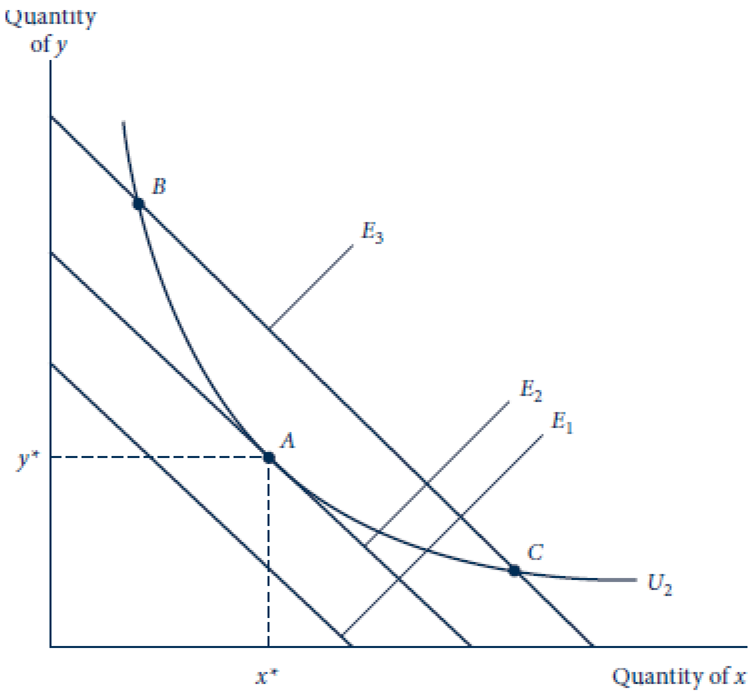

Max $XP_X + YP_Y$ st $U_0 = X^{\alpha}Y^{\beta}$

$$\ell = XP_x + YP_y + \lambda(U_0 - X^{\alpha}Y^{\beta})$$

$$\frac{d\ell}{dx} = P_x - \lambda\alpha X^{\alpha-1}Y^{\beta} = 0$$

$$\frac{d\ell}{dy} = P_y - \lambda\beta X^{\alpha}Y^{\beta-1} = 0$$

$$\frac{d\ell}{d\lambda} = U_0 - X^{\alpha}Y^{\beta} = 0$$

$$\lambda = \frac{P_x}{\alpha X^{\alpha-1}Y^{\beta}} = \frac{P_y}{\beta X^{\alpha}Y^{\beta-1}}$$

$$\frac{P_x}{P_y} = \frac{\alpha Y}{\beta X}$$

$$X = \frac{YP_y}{P_X}$$

$$U_0 = \left[\frac{YP_y}{P_X}\right]^{\alpha} Y^{\beta}$$

$$U_0 = \frac{P_y^{\alpha}}{P_x^{\alpha}}Y$$

$$Y^* = U_0\frac{P_x^{0.5}}{P_y^{0.5}}$$

$$X^* = U_0\frac{P_y^{0.5}}{P_x^{0.5}}$$

The indirect utility function is inversely related to the expenditure function

$$V = \frac{I}{2P_x^{0.5}P_y^{0.5}}$$

We replace I with E to denote expenditure and V with U. make E the subject of the formula, we have

$$E(P_x, P_y, U) = 2P_x^{0.5}P_y^{0.5}U$$

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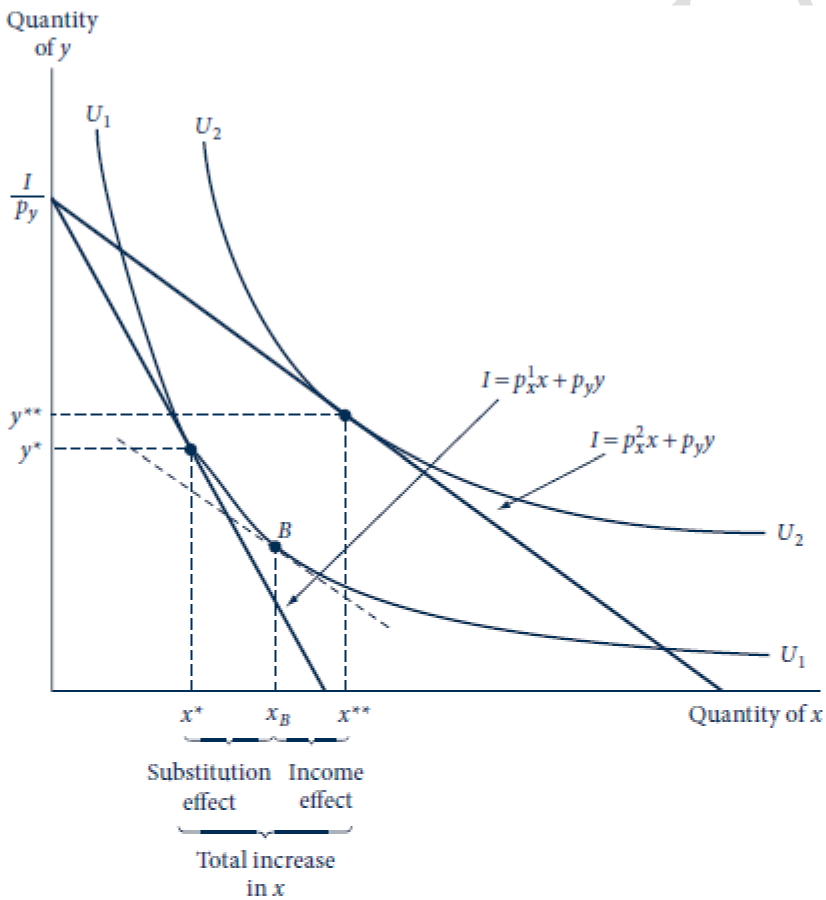
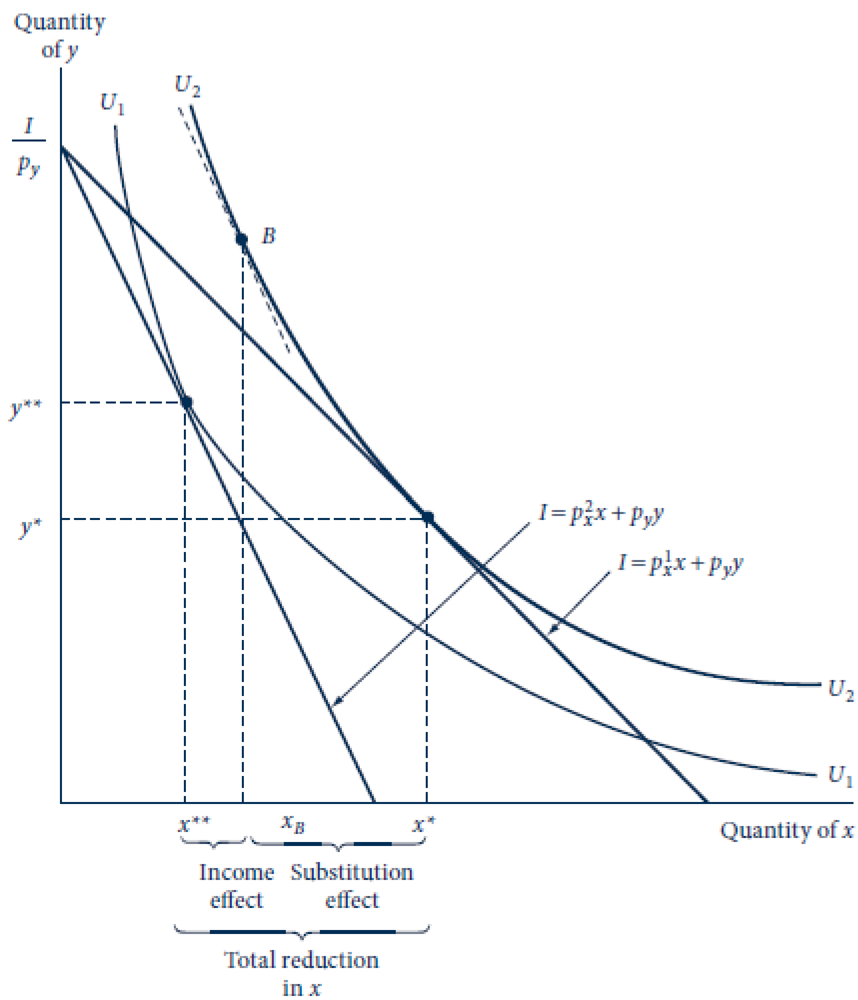
PRICE CHANGES

A decrease in the price of good X from P_x^1 to P_x^2 will result in the budget line to pivot outward and the new optimal point will be at a higher indifference curve. From the figure below, this is a movement from consuming Y*,X* on indiference curve U_1 to consuming Y**,X** on indiference curve U_2. This movement is broken down into two effects; substitution and income effect. Substitution effect is when a fall in price of good X makes good X cheaper relative to good Y, thus more of X is consumed at a given level of utility. Income effect, the fall in price of good X changes the real income to increase, thus an increase in income increases both comodities. A movement from X* to X_B is the substitution effect and from X_B to X** is the income effect. This is the Hickssian substitution and income effect



For a good that is an inferior good the substitution and income effect work in the opposite direction. An inferior good is a good whose quantity demanded reduces as income increases. A fall in the price of a good, the substitution effect will increase the quantity of a good consumed to be on the same indifference curve while the income effect will reduce the amount demanded.

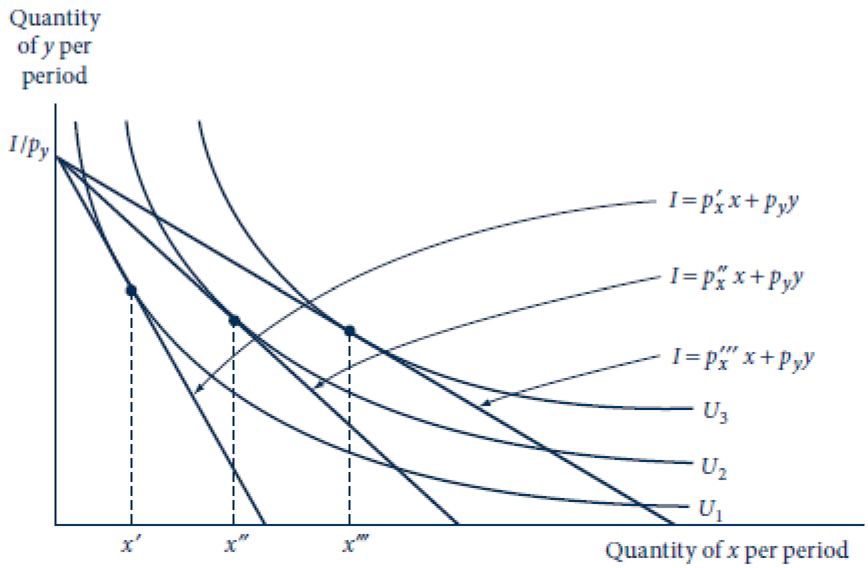
The figure below shows the substitution and income effect of an inferior good.

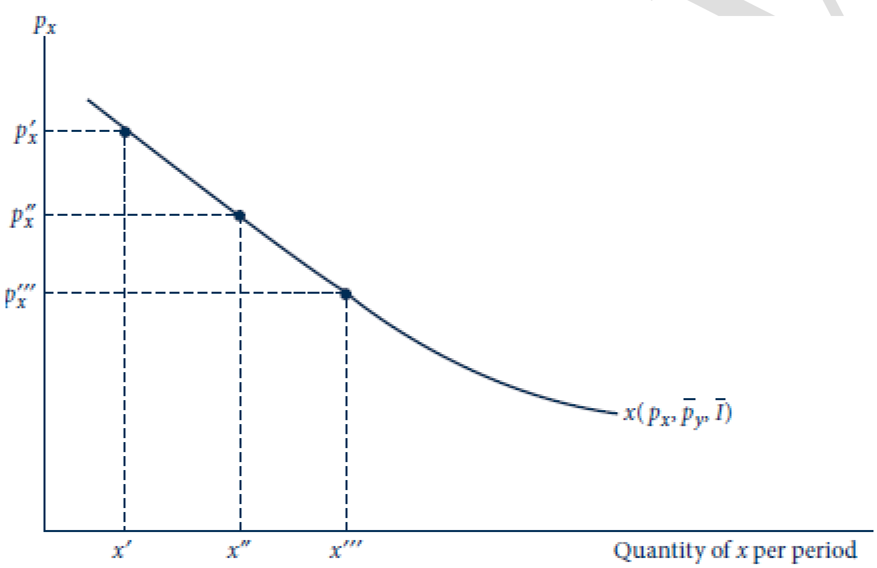


In the figure above, the price of good X increases from P_x^2 to P_x^1. The substitution effect makes us move from X* to X^B. The income effect is a movement from X^B to X**. Since the substitution effect and income effect are both negative the result is the fall in quantity demanded.

DEMAND FUNCTIONS

The uncompensated demand function is also called the Marshallian demand function which is derived from utility maximization. The figure below shows an indifference map for an individual when faced with different prices. Our initial point is starting from point X' with price $P_x^{'}$. When the price falls we move to a new budget line at a higher indifference curve.

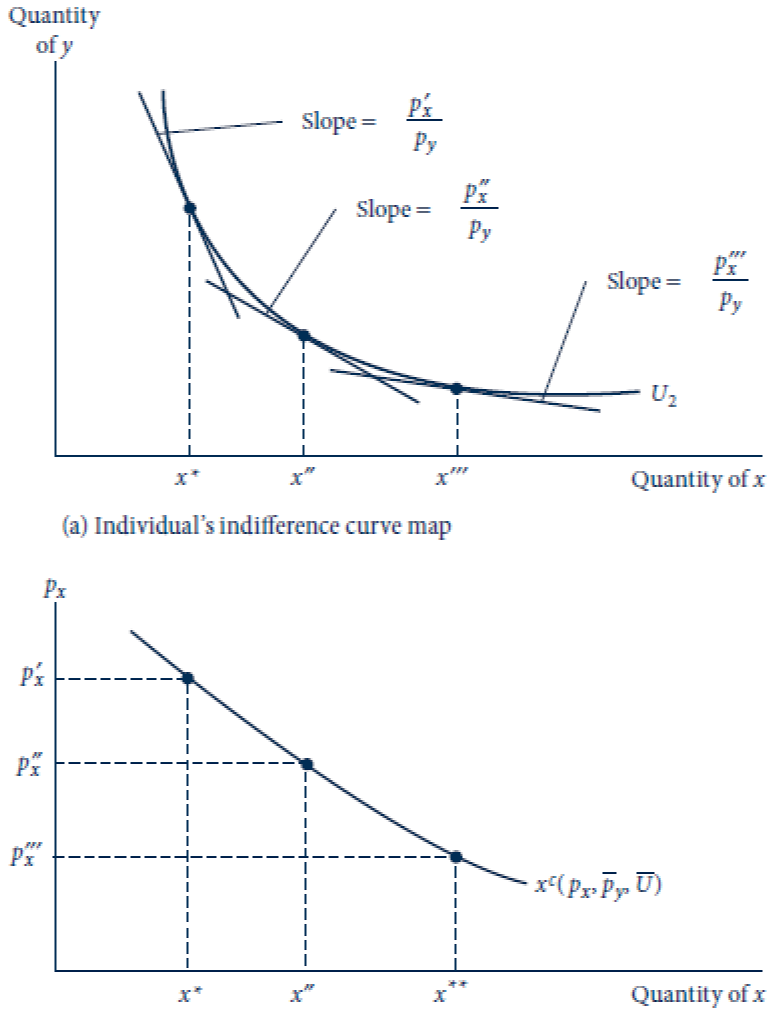




We plot the price with the quantities demand we derive a demand function as above.

The compensated demand function is also known as the **Hicksian demand function** shows the relationship between the price of a good and the quantity purchased on the assumption that other prices and utility are held constant. Expenditure minimization gave us the compensated demand function.

Prices will change as we stay on the same indifference curve so as to keep utility constant. The figure below illustrates this.



(a) Individual's indifference curve map

(b) Compensated demand curve

Shepards lemma

From expenditure minimization we derived the langrage function

$$\ell = XP_x + YP_y + \lambda(U_0 - X^{\alpha}Y^{\beta})$$

The solution was the expenditure function $E(P_x, P_y, U) = 2P_x^{0.5}P_y^{0.5}U$.

To get the compensated demand function we derive the expenditure function with respect to the prices of the commodities

$$\frac{\partial E(P_x, P_y, U)}{\partial P_x} = X^C(P_x\, P_y\, U)$$

Example

Suppose $U(x,y) = X^{1/2}Y^{1/2}$. Income is M = 72. The price of y is 1 and the price of x changes from 9 to 4. Calculate the income effect (IE) and the substitution effect (SE).

The marshallian demand functions are given as

$$X^* = \frac{I}{2P_x} = \frac{72}{2\times 9} = 4$$

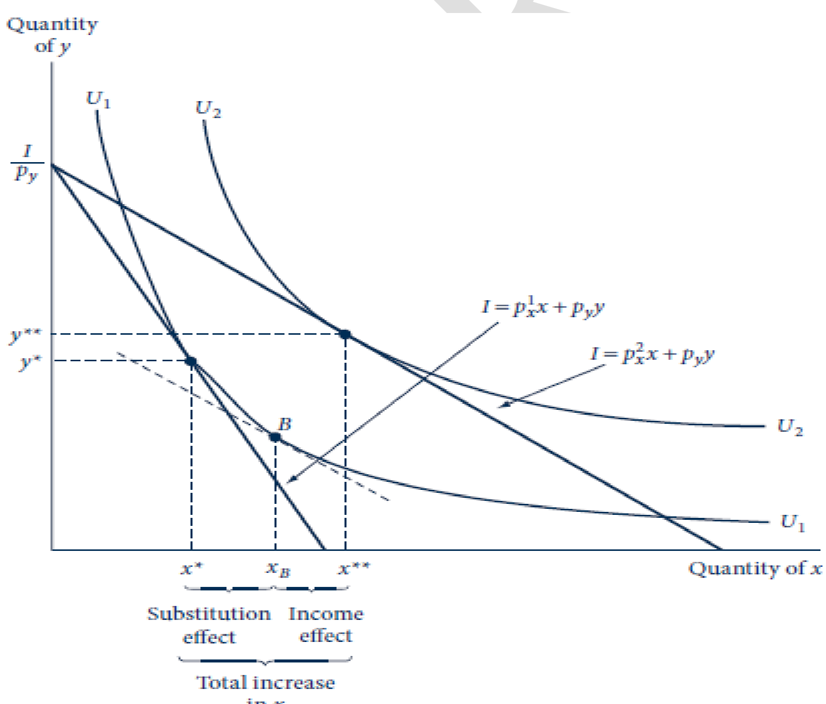
$$Y^* = \frac{I}{2P_y} = \frac{72}{2} = 36$$

The optimized utility which is the indirect utility function is given

$$U_0 = \frac{I}{2\sqrt{P_x P_y}} = \frac{72}{2\sqrt{4}} = 18$$

This is the utility level at which the original budget line is tangent to the indifference curve.

Total price effect, which is the movement from the initial optimal point(X*) to the higher optimal point(X**).



Total effect= $\frac{I}{2P_x^2} - \frac{I}{2P_x^1} = \frac{72}{2*4} - \frac{72}{2*9} = 5$

The movement from X* to X^B is the substitution effect. We are keeping utility constant and we a on a budget line with reduced income but a slope that has the new price for X. which means we need to calculate the amount of income that would give us utility equal to 18 at price 4.

$$\frac{I - \Delta I}{2\sqrt{P_x P_y}} = 18$$
$$\frac{72 - \Delta I}{2\sqrt{4}} = 18$$
$$I - \Delta I = 48$$

At the reduced income of 48 and price 4, the demand is

$$\frac{48}{2*4} = 6$$

Meaning

SE= $\frac{I - \Delta I}{2P_x^2} - \frac{I}{2P_x^1} = 6 - 4 = 2$

$$IE = \frac{I}{2P_x^2} - \frac{I - \Delta I}{2P_x^2} = \frac{\Delta I}{2P_x^2} = \frac{24}{2*4} = 3$$

WELFARE MEASURES:CONSUMER SURPLUS,COMPENSATING AND EQUIVALENT VARIATIONS

Consumer surplus (CS) is the area under the (inverse) demand curve and above the market price up to the quantity purchased at the market price. We can measure the welfare effect of a price rise by calculating the change in Consumer Surplus.

Deadweight loss is any part of Consumer surplus that does not get translated into revenue or profits. The extent of deadweight loss generated is a measure of inefficiency associated.

However, Consumer surplus is not an exact measure because of the presence of an income effect. Ideally, we would use the compensated demand curve to calculate the welfare change.

Compensating variation and Equivalent give us two such measures.

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Compensating variation is the amount of money that must be given to a consumer to offset the harm from a price increase, i.e. to keep the consumer on the original indifference curve before the price increase.

Equivalent variation is the amount of money that must be taken away from a consumer to cause as much harm as the price increase. In this case, we keep the price at its original level (before the rise) but take away income to keep the consumer on the indifference curve reached after the price rise.

Example

Suppose that a consumer has the utility function $U = X^{1/2}Y^{1/2}$ He originally faces prices (1; 1) and has income 100. Then the price of good 1 increases to 2. Calculate the compensating and equivalent variations.

$$X^* = \frac{I}{2P_x} = \frac{100}{2} = 50$$

$$Y^* = \frac{I}{2P_y} = \frac{100}{2} = 50$$

The optimized utility which is the indirect utility function is given

$$U_0 = \frac{I}{2\sqrt{P_x P_y}} = \frac{100}{2} = 50$$

When price increase to 2 utility is

$$U_1 = \frac{I}{2\sqrt{P^2{}_x}} = \frac{100}{2\sqrt{2}} = 35$$

Compensating variation we maintain U_0 by increasing income

$$U_0 = \frac{I + CV}{2\sqrt{P_x^2}} = \frac{100 + CV}{2\sqrt{2}} = 50$$

$$CV = 41.4$$

Equivalent variation we reach the new utility U_1 by reducing income

$$U_1 = \frac{I - CV}{2\sqrt{P_x^1}} = \frac{100 - CV}{2} = 35$$

$$EV = 29.29$$

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2.7 ACTIVITIES

1. Suppose $U = X^{\alpha}Y^{\beta}$, where α + β= 1. Income is I. Calculate the price elasticity, cross-price elasticity and income elasticity of demand for x.?
2. Explain the concept of a price change, substitution and income effect under slutsky. Please calculate the two effects.
3. Guillermo's utility function for doughnuts(x) and popcorns(y) is$U = X^{\frac{1}{2}}Y^{\frac{1}{2}}$. Theprice per doughnut is 9 and the price per package of popcorns is 16.
   a. Consider some arbitrary level of utility U_0. Find the minimum level of expenditure on doughnuts and popcorns that can attain U_0.
   b. How much x and y are in the bundle in part a.
   c. Suppose the price of x increases from 9to 25. Calculate the compensating variation?
   d. Calculate the equivalent variation.

2.8 SUMMARY

In summary we have looked at;

- Preferences
- Indifference curves
- Price changes
- Utility maximisation and expenditure minimisation
- Marshallian and Hicksian demand function
- Consumer surplus, compensating and equivalent variation

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3.0 UNIT TWO: HOUSEHOLD AS A SUPPLIER

3.1 INTRODUCTION

In this unit we look at how individuals make decision on what quantities of factors of production they will supply to the firms. Households are the owners of labour and capital, so they determine how much of their time they will spend in labour or in leisure. This decision is made considering the time constraint that nature poses. Another decision is on how much to spend in the current period and the later periods. The decision to consume or save now offers firms capital funds for the expansion of production.

We will look at the labour market and supply of labour, and intertemporal choice.

3.2 AIM

The aim of this unit is to ensure that the student can mathematically model how individuals make decision to work, consume and save.

3.3 OBJECTIVES

At the end of this unit you should be able to do the following

- Derive a budget constraint and indifference curve for the leisure-consumption decision
- Explore how individuals respond to changes in wage rate
- Derive a backward bending supply curve
- Construct an intertemporal budget constraint
- Explore how individuals respond to changes in interest rates

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3.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

3.5 REFLECTION

what would make you want to spend your lifetime working than enjoying your leisure time?

3.6. READINGS

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 5.

LABOUR SUPPLY

We are focusing on the decision an individual has to make between working and spending time in leisure. We have a limited number of hours in a day to work and you can decide how many hours would be spent in working so that you earn an income or how many would be spent in leisure. By leisure we mean all activities that can be done that cannot be classified as work. An individual is endowed with time T and can spend N hours in leisure and T-N hours in labour. He/she earn a wage of W for each of labour supplied. The income earned is used for consumption of any commodity, there we denote consumption as C. the two economic goods that we are dealing with is leisure and consumption, so the individual has to make a decision of the hours of labour so as to consume the commodities. Therefore,

$$C = w(T - N)$$
$$C + wN = wT$$

This is a budget constraint for the individual. if the individual has some income that s/he receives whether working or not, this is non-labour income that we denote M. then,

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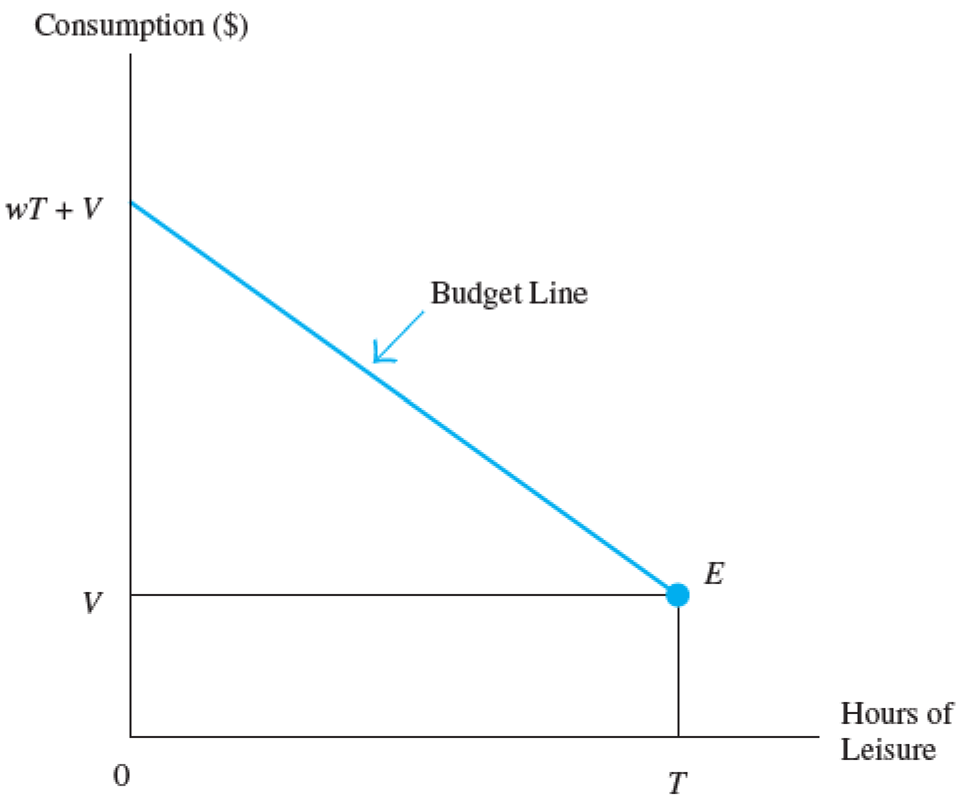
$$C = w(T - N) + M$$
$$C + wN = wT + M$$

If all T hours were spent in leisure, the individual only has no-labour income for his consumption. If all hours were spent in labour then the individual has wT+M as the income available for consumption. The budget constraint on a graph looks like;



If the individual spends all hours in leisure he forgoes the wage w that he could earn. If he gives up one hour of leisure and spends one hour in labour he earns a wage w and he consumes w+M. therefore, the wage is the opportunity cost of leisure and thus it is the slope of the budget line.

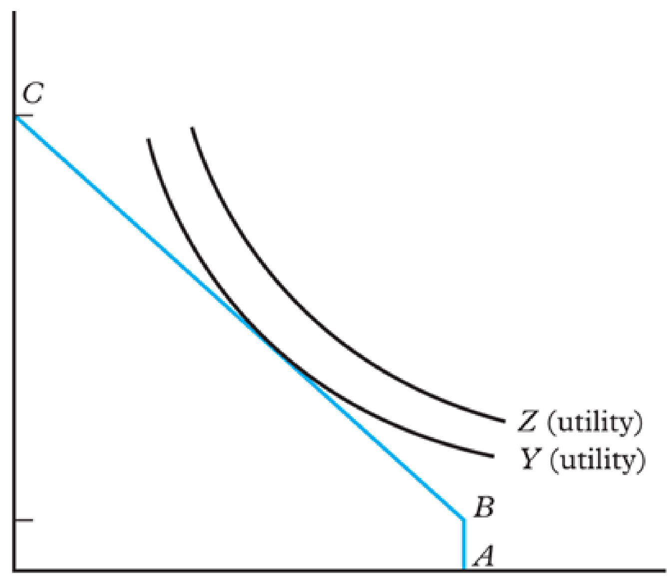
A person will choose a combination of leisure and consumption that maximises utility given the budget constraint.

Max $Utility = U(C, N)$ st $C + wN = wT + M$

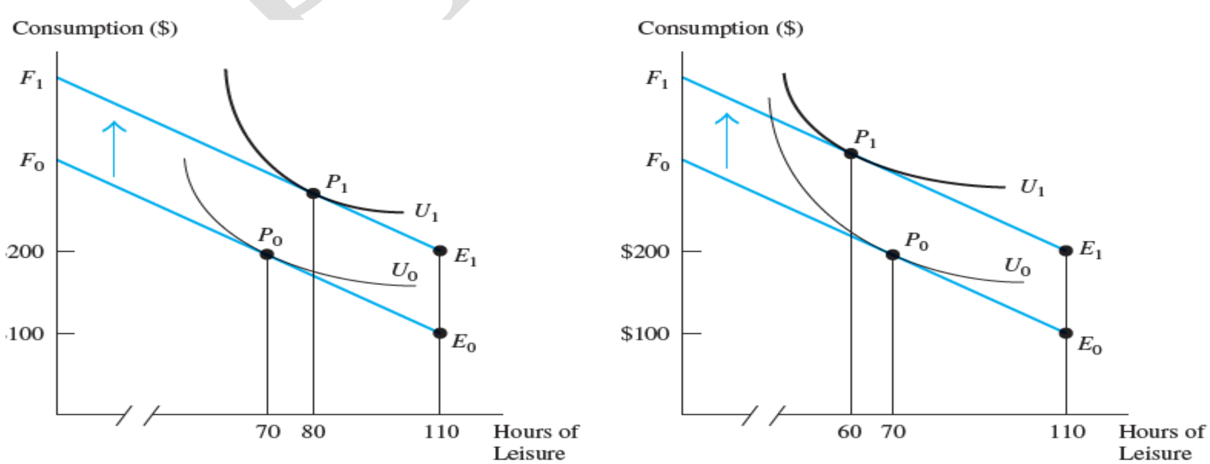
$$\frac{MU_N}{MU_C} = -w$$
$$MRS_{CN} = -w$$

The optimal number of hours spent in leisure and the consumption bundle consumed is at the point of tangency between the budget constraint and the indifference curve. The individual

maximises utility. The number of hours of labour at the optimal point is just a subtraction of the endowment time T and the optimal number of leisure N. the graph below shows the optimal point that is tangency of the budget constraint and indifference curve with consumption on the y-axis and leisure on the y-axis.



Change in non-labour income will shift the budget constraint upwards or downwards. If non-labour increased the budget constraint shifts upwards but parallel because the slope is the same. An increase in non-labour income increases income available for consumption, so if leisure is a normal good, it will increase will labour reduces. If leisure is an inferior good, it will reduce and labour increases. The graph below shows when leisure is inferior and a normal good.

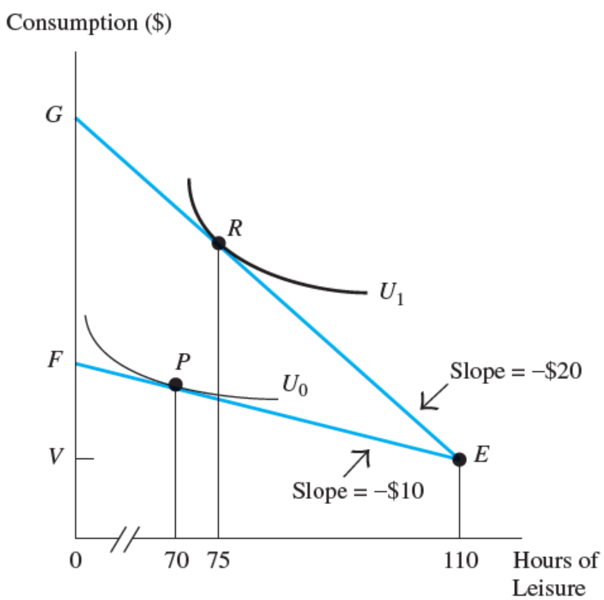


(a) Leisure Is a Normal Good

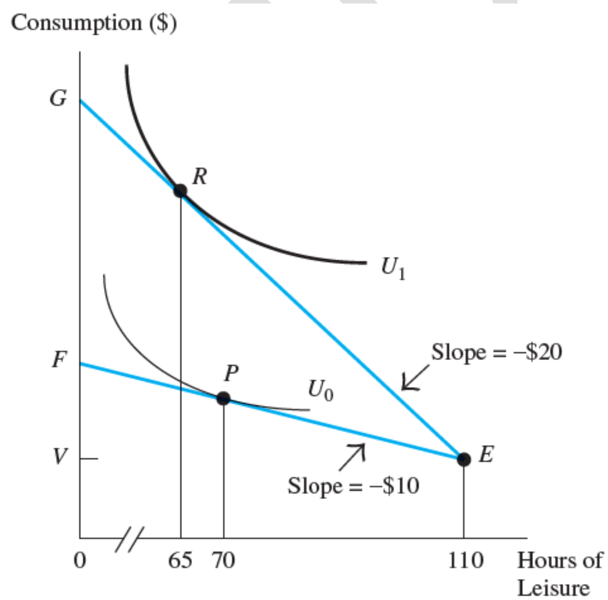
(b) Leisure Is an Inferior Good

A change in wage rate changes the slope of the budget constraint but it still starts from the non-labour income M. A person would express two attitudes when wage increases. The first is since the wage has increase I don't have to work hard, if I want to maintain the same level of consumption as before I supply less labour. The second attitude is an increase in wage will motivate me to work hard thus supplying more labour. The graph below shows the two attitudes.

Pane (a)



Panel (b)



Panel a shows a decrease in labour at higher wage and panel b shows an increase in labour supplied. The movement from P to R can be broken into substitution and income effect.

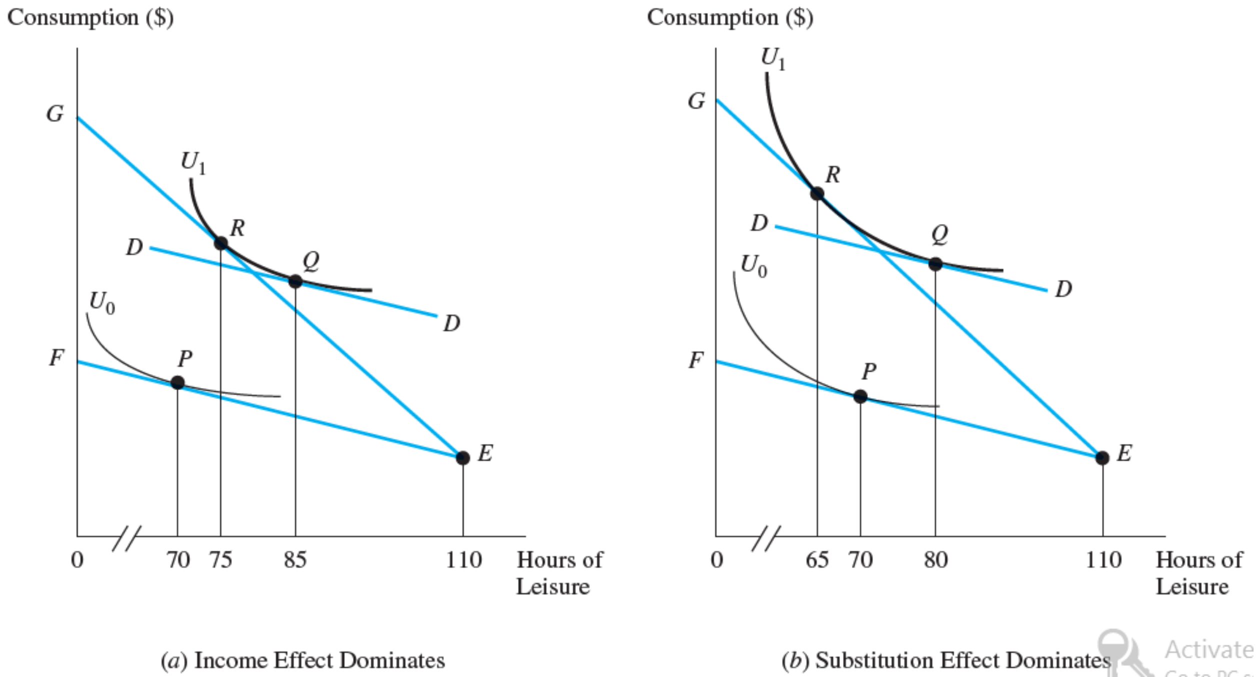
Substitution effect is substituting a relative expensive good for a relative cheap good. If wages increase, leisure becomes expensive relative to consumption therefore less of leisure and more of labour is supplied. **Income effect** is the increase in income increases the consumption of both commodities if leisure is a normal good and reduces leisure if its an inferior good.

When the substitution effect dominates the income effect labour supplied is reduced. When income effect dominates the substitution effect labour supplied is increased.

The graph below shows an effect of a wage fall on leisure consumption bundles. A fall in wages moves equilibrium from R to P. a movement from R to Q is the substitution effect and a movement from Q to P is the income effect.

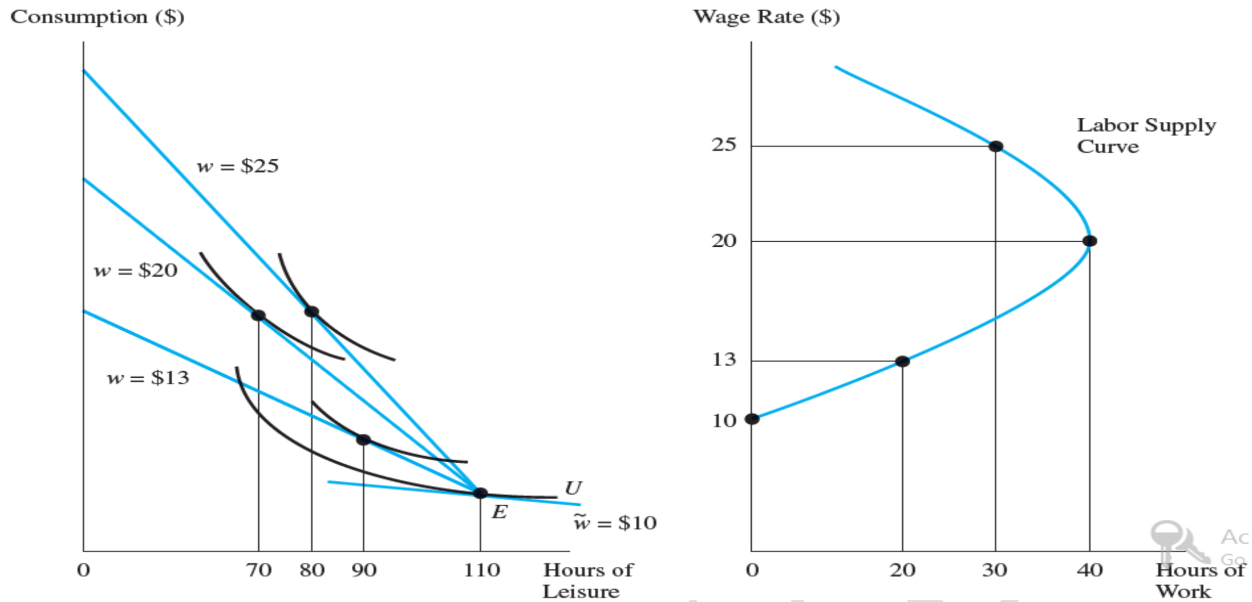
Panel a shows when income effect dominates the substitution effect and the result is an increase in the supply of labour. Panel b shows substitution effect dominating the income effect and the result is a fall in labour supplied.

Panel (a) Panel(b)



Labour supply curve

Labour supply curve traces the relationship between wage and labour hours supplied. When the substitution effect dominates income effect we have an upward sloping supply curve and when income effect dominates we have a downward sloping supply curve. When we put the two situations on graph we get a backward bending supply curve. Wages below 20 the supply curve is upward sloping because an increase in wage more labour is supplied. Above 20, an increase in wage reduces the hours of labour supplied



An introduction of a tax on wages affects the slope of the budget constraint and has the same effect as the change in wages.

3.8 intertemporal choice

We are looking at how a consumer spreads their income between two periods that is present and future consumption. If a consumer has income I in the present and in the future, s/he can decide whether to spend all the money on consumption in both periods or can decide to save some money in the present and spend it in the future or spend more in the present by borrowing from future income and spend less on consumption in the future. A consumer can borrow and save money at an interest rate r.

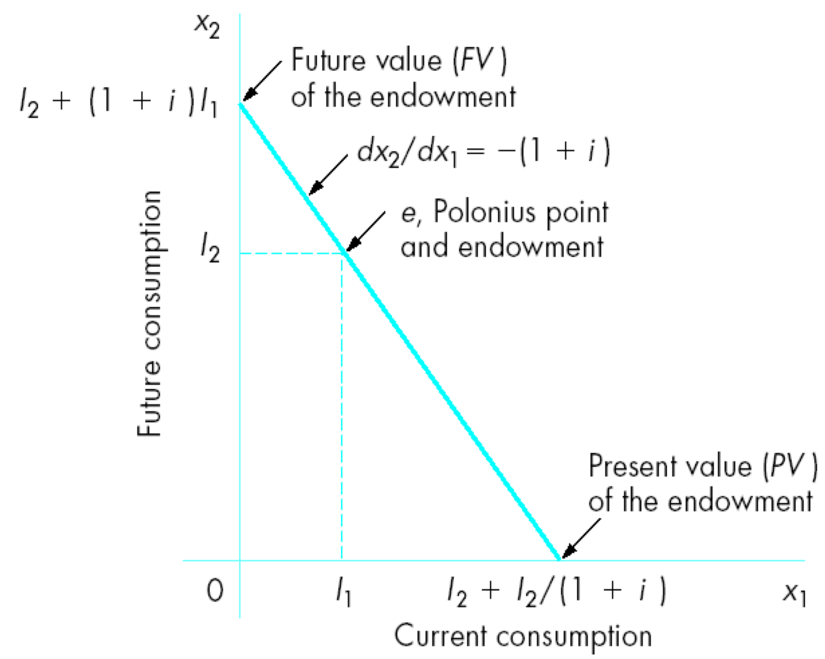
if present income is saved for future consumption then in period two the consumer has $I_0(1+r)+I_1$ as the total future consumption. This $I_0(1+r)$ is the future value of present income.

If future income was to be spent in the present, the total consumption is $I_0+\frac{I_1}{(1+r)}$. this $\frac{I_1}{(1+r)}$ is the present value for income in period two.

An individual's budget constraint is

$$c_0+\frac{c_1}{(1+r)}=I_0+\frac{I_1}{(1+r)}$$

This implies that the total present value of consumption in period 1 and 2 should be equal to the total present value of income in period 1 and 2.



source; micheal wetzstein

The graph shows present consumption on the x-axis and future consumption on the Y-axis. Income in period 1 and 2 give us the endowment point. The slope of the budget constraint is $-(1+r)$

The consumer has a utility function that s/he must maximise subject to the budget constraint.

$$\max U(c_0, c_1) \text{ st } c_0 + \frac{c_1}{(1+r)} = I_0 + \frac{I_1}{(1+r)}$$

The optimal point is the tangency between the indifference curve and the budget line. The slope of the budget line is equal to the marginal rate of substitution.

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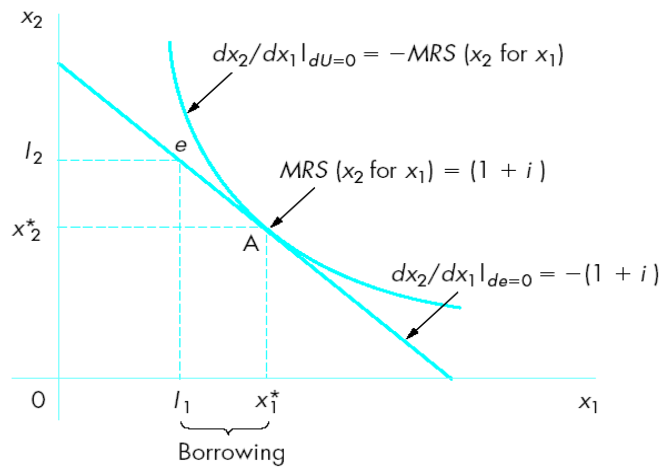
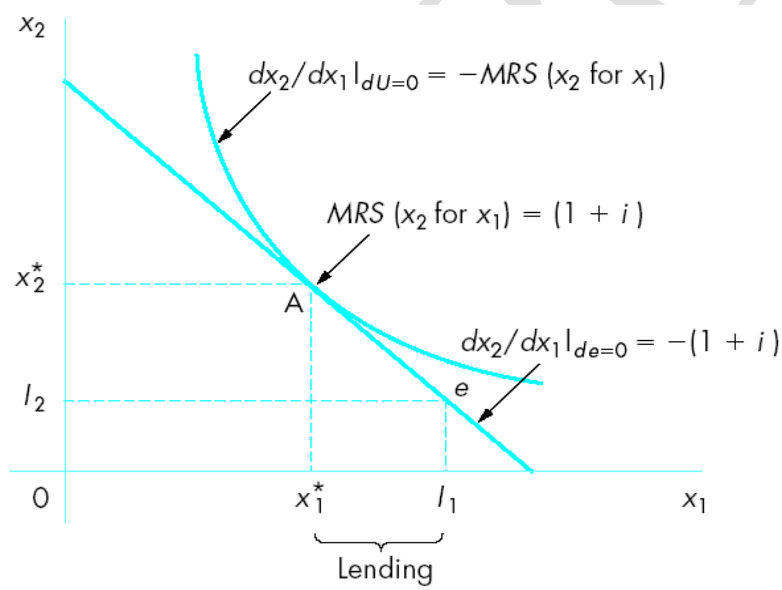


source: micheal wetzstein

If the optimal point is below the endowment point, the consumer is a borrower. Because present consumption is greater than present income. Future income and has been forgone. The cost of present consumption is the interest rate to be repaid in future.

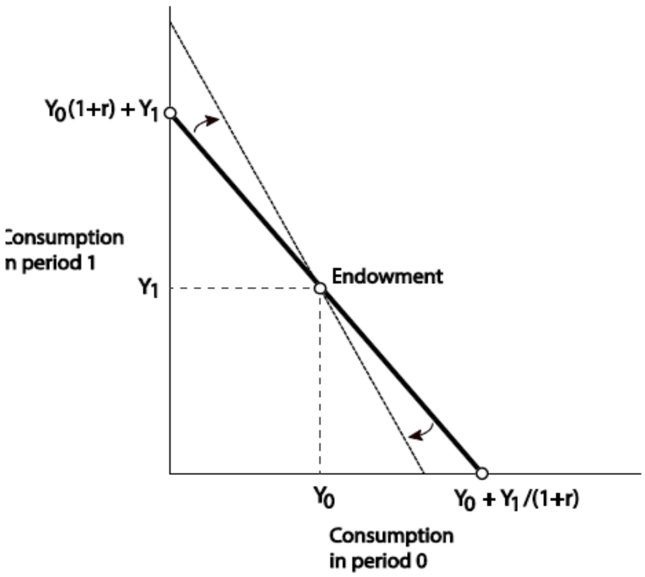
If the optimal point is above the endowment point, the consumer is a saver. Present consumption is less than present income, therefore the difference is saved for future consumption. Thus the consumer receives interest rate on the money saved.



source:micheal wetzstein

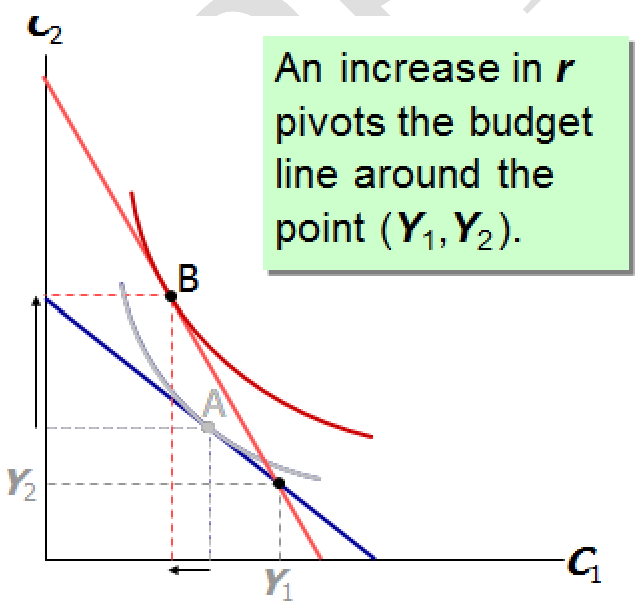
When a consumer is neither a borrower nor a saver, the optimal point is on the endowment point because s/he consumes exactly what s/he earn in each period.

A change in interest rate affects the slope of the budget constraint. The budget constraint pivots around the endowment point since income in both periods has not change. Lets say interest rate increase, means that the new budget line is steeper



source: morgan,kats&rosen

If a consumer is a saver, an increase in interest rate will increase the amount of money received in interest for future consumption. The consumer will either increase the amount of money saved or reduce the amount of money saved because he receives more in future for a small amount saved.



source: Mankiw 2007

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Whether we say more or less depends on the size of the substitution and income effect.

- **income effect**: If consumer is a saver, the rise in ***r*** makes him better off, which tends to increase consumption in both periods. For a borrower, a rise in the interest rate lowers income tomorrow, the agent should consume less in period 0 (borrow less).

- **substitution effect**: The rise in ***r*** increases the opportunity cost of current consumption, which tends to reduce $\boldsymbol{C}_0$ and increase $\boldsymbol{C}_1$.

3.9 present value

Suppose we have a stream of payoffs $y_0, y_1, y_2, ... y_n$ in periods 0,1…. n, respectively.

Suppose the rate of interest is given by r. The present value in period 0 of this stream of payoffs is given by:

$$PV = \frac{y_0}{(1+r)} + \frac{y_1}{(1+r)^1} + ... \frac{y_n}{(1+r)^n}$$

If the stream of payoff are constant and will be given for infinite then the present value of these payoffs is

$$PV = \frac{y_0}{r}$$

A bond typically pays a fixed coupon amount x each period (next period onwards) until a maturity date T, at which point the face value F is paid. The price of the bond, P, is simply the present value given by:

$$PV = \frac{x}{(1+r)} + \frac{x}{(1+r)^1} + ... \frac{x}{(1+r)^T} + \frac{F}{(1+r)^T}$$

The price of a CONSOL bond is given by $P = \frac{x}{r}$

Activities

1. Analyse the effect of an increase in interest rate of a borrower
2. Jenifer lives two period. In the first period her income is fixed at $10,000. In the second period it is $20,000.she can borrow and lend at the market interest rate of 7 percent
   a. Sketch her intertemporal budget line
   b. The interest rate increases to9 percent. Sketch her budget constraint
   c. What effect do you expect it to have on her savings?
   d. Suppose Jenifer is unable to borrow at any rate of interest, though can still lend at 9percent. Sketch her budget constraint?
3. The government levies a 30percent wage tax on Cleo. It uses the money to finance a parade. The parade's value to cleo is just sufficient to make her as well off as she was before the tax levy. What is the effect of government tax and expenditure package on clea's labour supply?

3.7 ACTIVITIES

1. one proposal for reforming the welfare system is a negative income tax. under a negative income tax ,each person is entitled to a grant of $G per month. For every dollar you earn, the grant is reduced by $t

a). suppose G=100 and t=0.25.consider an individual whose hourly wage is $8. Sketch the budget constraint before and after the introduction of a negative income tax.

b). how would a negative income tax affect labour supply?

2. Jennifer lives two periods. In the first period her income is fixed at $10,000; in the second period it is $20,000. She can borrow and lend at the market interest rate of 7 percent

a).sketch her intertemporal budget constraint

b) the interest rate increases to 9 percent. Sketch the new budget constraint. What effect do you expect this change to have on her saving?

c)suppose she is unable to borrow at any rate of interest, although she can still lend at 9 percent. Sketch her budget constraint.

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3.8 SUMMARY

We have looked at the household being the the supplier of inputs. The concept of utility maximisation is still applicable. We have looked at;

- Labour supply, the commodities between which individuals chooses are leisure and consumption.
- When the wage rate changes both income and substitution effects arise
- Capital supply, the commodities between which individual chooses are current consumption and future consumption
- When interest rate changes, the budget constraint pivots through the endowment points, whether savings increases or decreases depends on the relative strengths of the income and substitution effects.

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4.0 UNIT THREE: CHOICE UNDER UNCERTAINTY

4.1 INTRODUCTION

In this unit we look at how individuals make decision in an uncertain environment. An uncertain environment involves risk; therefore an individual's preference involves their attitude towards risk. They could be risk lovers, averse and neutral. As most people are risk averse the market for insurance arises so as to cover some of the risk involved.

4.2 AIM

The aim of this unit is to introduce the expected utility model to evaluate risk prospect.

4.3 OBJECTIVES

At the end of this unit you should be able to do the following

- calculate the expected value of a gamble
- explain the nature of the vN-M utility function and calculate the expected utility from a gamble
- explain the different risk attitudes and what they imply for the vN-M utility function
- analyse the demand for insurance and show the relationship between insurance and premium

4.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

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4.5 REFLECTION

Think of a world where you knew the outcome of any event, would decision making be that difficult?

4.6. READINGS

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 6.

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing

Gambles and contingent commodities

Random variable: A random variable is a variable that records, in numerical form, the possible outcomes from some random event.

Expected value of a random variable: The outcome of a random variable that will occur ‘‘on average.’’ The expected value is denoted by E(x). If x is a discrete random variable with n outcomes, then $E(x)=\sum x_i f(x)$.

If x occurs with probabilities then $E(x)=\sum x_i p_i$.

A fair gamble is one that gives you expected value equal to zero. If you toss a coin with equal probability(0.5) of getting a head or tail, and if a head turn up you receive K50 and if a tail turn up you give K50

$$E(x)=\sum x_i p_i = 0.5\times 50+0.5(-50)=0.$$

Unfair gambles are those whose expected value are not zero. In the coin game, you are promised K100 if heads turn up and you give K50 if a tail turns up

$$E(x)=\sum x_i p_i = 0.5\times 100+0.5(-50)=25.$$

Consider an individual has income K100 and is offered to bet on the following gamble. For each kwacha he bets, he loses K1 if a heart appears and wins K0.4 if a club, spade or diamond appears. How much would he bet?

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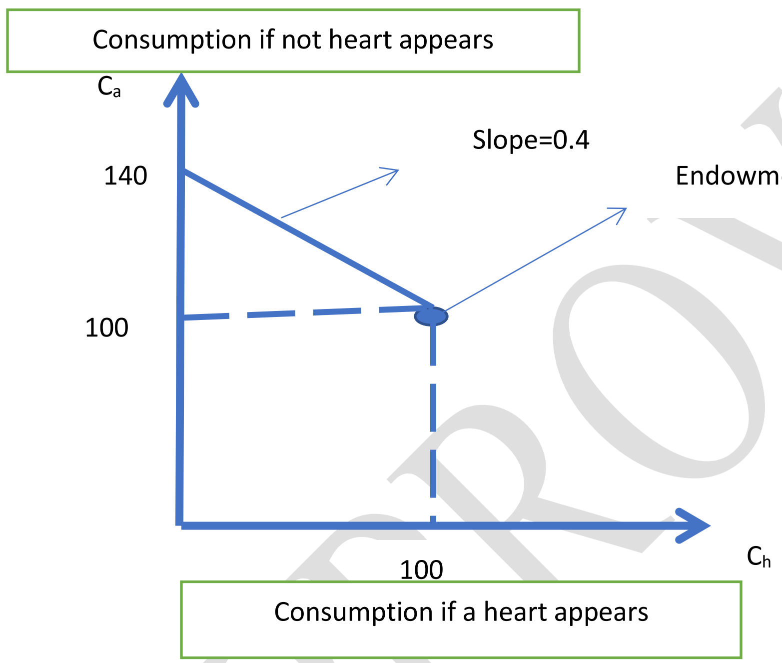
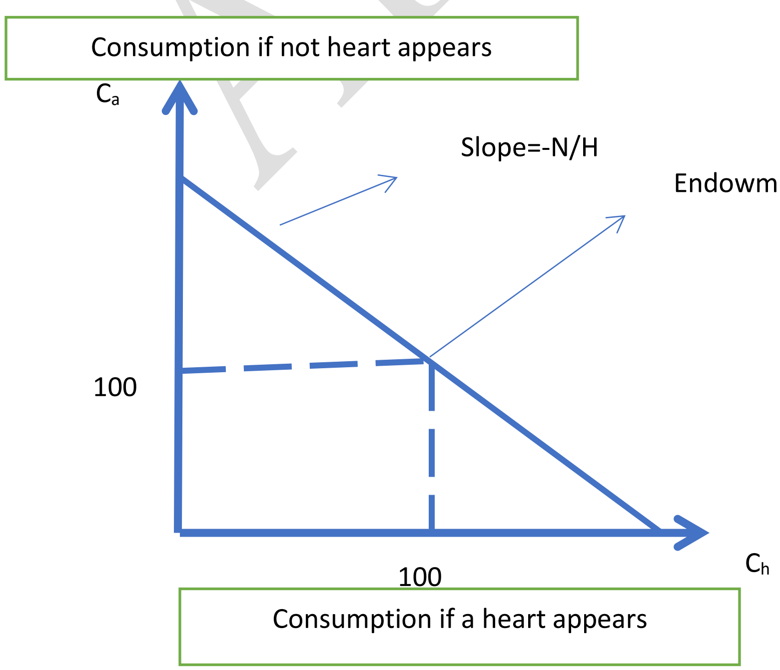
The consumer consumes a composite good c_h if a heart appears and c_a if all other cards appear. If s/he bets K10, he consumes K90 if a heart appears because he loses .K10.if all other cards appear ,he wins K4 and consumes K104. In the event he bets the entire K100, he consumes zero if a heart appears and consumes K140 if all other cards appears.

C_h and c_a are called contingent commodities because their level depends on which state of the world occurs. Tracing out the level of consumption on each dollar he bets gives a budget constraint. The endowment point is the amount of consumption available if the bet is not taken. Regardless of which state of the world occurs the consumer only has K100 for consumption



The budget constraint would extend to the x-axis if we let the consumer take the other side of the bet. That is, s/he wins K1 if a heart appears and loses K0.4 if all other cards appear



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In general the slope of the budget constraint is calculated as –N/H, where N is the change in consumption C_a and H is the change in C_h.

The probability of drawing a heart is ¼ and all other cards is ¾. Therefore the expected value of the gamble is 0.05 implying that it is not a fair game

$$E(x) = \frac{3}{4}(0.4) + \frac{1}{4}(-1) = 0.05$$

A fair odds line reflects opportunities presented by a fair game. The slope of this line gives the odds ratio

$$slope = \frac{p}{1-p}$$

The expected value of consumption is equal at every bundle on the fair odds line.

The von Neumann–Morgenstern utility index

Suppose you are faced with a gamble G that yield x_1 with probability p_1, x_2 with p_2 and x_n with p_n. There exists a utility function u so that the expected utility of the gamble is given as

$$E(UG) = p_1 u(x_1) + p_2 u(x_2) + ... + p_n u(x_n)$$

The curvature of the utility function shows preference towards risk. We have risk aversion which implies preferring a sure outcome to one that involves risk, risk neutral is when you are indifferent between a risky and a certain outcome. Risk loving is when you prefer an outcome that has risk to a sure one.

Risk aversion

A concave vNM utility function indicates that the individual is risk averse. A risk averse person prefers a sure thing than a risk one. s/ he would not take a fair gamble because the expected utility of a gamble is less than the utility of his or her wealth when s/he does not gamble.

Suppose G is a gamble which yields 20 with probability 1/2, and 10 with probability

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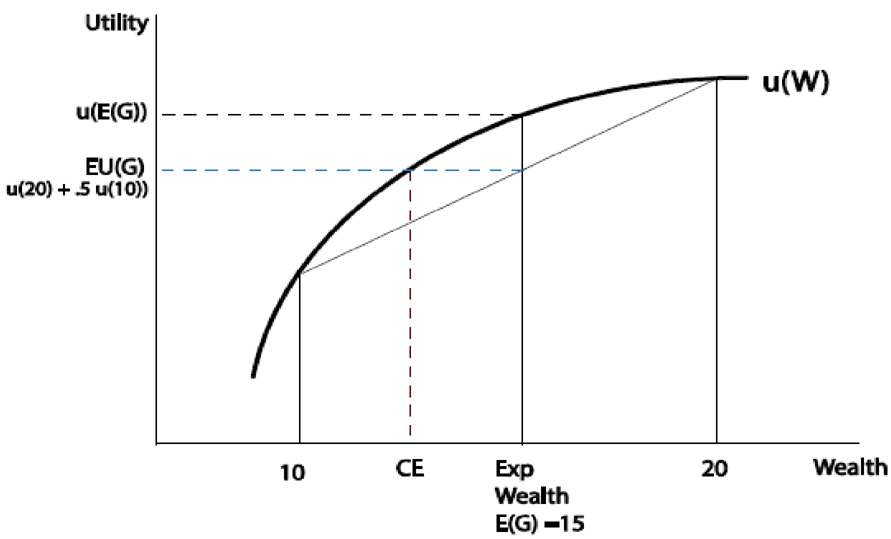
1/2. Suppose an agent has wealth 15 and is given the following choice: invest 15 in gamble G, or do nothing. Note that the expected value of the gamble, E(G), is exactly 15, so that this is a fair gamble (the expected wealth is the same whether G is accepted or rejected).

The expected utility of G is

$$E(uG) = \frac{1}{2}U(20) + \frac{1}{2}U(10)$$

For a concave function

$$E(uG) < u(15) = u(EG)$$



Insurance

A risk-averse individual would pay to obtain insurance. The Certainty Equivalence (CE) of a gamble is the certain wealth that would make an agent indifferent between accepting the gamble and accepting the certain wealth. As Figure above shows, the CE is lower than the expected income of 15. This agent would be willing to pay a positive amount to buy insurance. How much would the agent be willing to pay? The amount an agent pays for insurance is called the risk premium.

Suppose you have a utility function

$U = \sqrt{W}$

Wealth is uncertain. With probability 0.5 wealth is 100, and with probability 0.5 a loss occurs so that wealth becomes 64. The insurance company offers to pay you 36 whenever the loss occurs and in exchange you pay them a premium of R in every state.

$E(W) = 0.5(100) + 0.5(64) = 82$ this is the expected wealth

$U[E(W)] = \sqrt{0.5(100) + 0.5(64)} = 9.055$ this is of the utility of the expected value

$E[(U(W)] = 0.5\sqrt{100} + 0.5\sqrt{64} = 9$ this is the expected utility

Since the expected utility is less than the utility of the expected wealth, the person is risk averse. Whats the maximum premium paid

$U(CE) = E[U(w)]$

$\sqrt{CE} = 9$

$CE = 81$

100-81=19 is the maximum premium the person is willing to pay for the insurance coverage of 36

How much insurance?

Suppose a risk-averse agent has wealth W, but faces the prospect of a loss of L with probability p, where 0 < p < 1. The agent can buy a coverage of X by paying the premium rX.

The wealth if loss occurs is given by $W_L = W - L + X - rX$, and the wealth when no loss occurs is given by $W_N = W - rX$. The expected utility of the agent is:

$E[(U(W)] = pu(W_L) + (1-p)u(W_N) = pu(W - L + X - rX) + (1-p)u(W - rX)$):

Maximize with respect to X

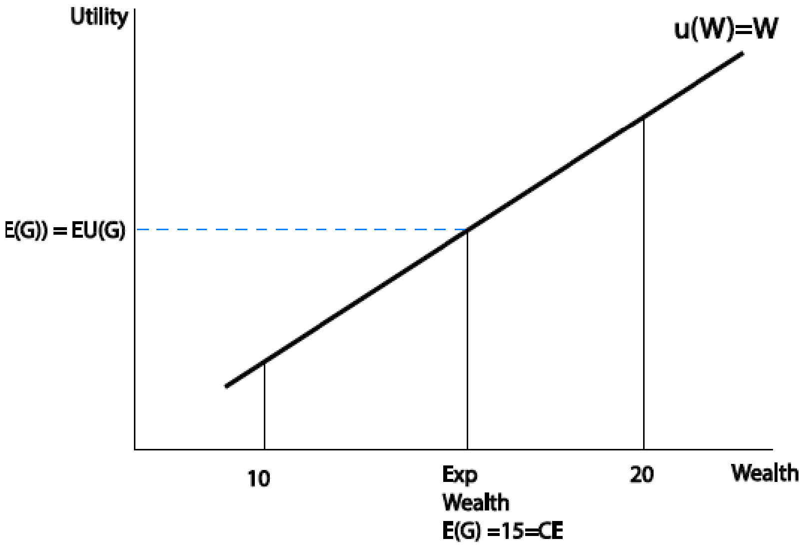
$pu^{'}(W_L)(1-r) + (1-p)u^{'}(W_N)r = 0$

$\frac{U^{'}(W_L)}{U^{'}(W_N)} = \frac{(1-p)r}{(1-r)p}$

If insurance is fair, the expected payout pX is equal to the expected receipts rX. Then p=r.

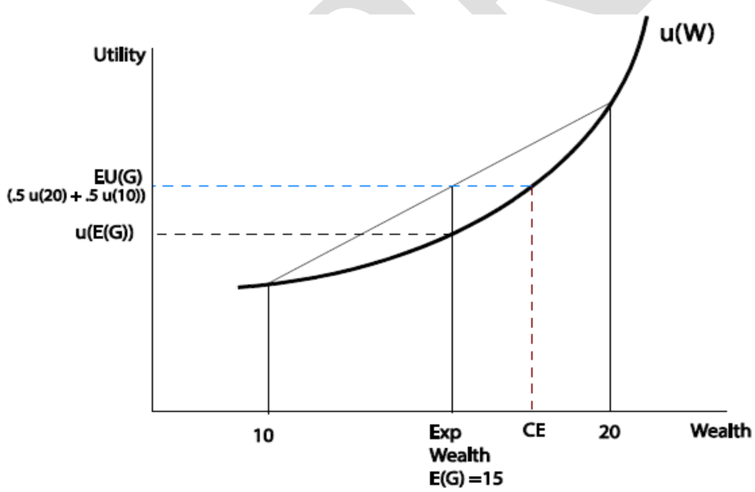
Risk neutral

A risk-neutral agent does not care about risk and only cares about the expected value of a gamble. The agent is indifferent between accepting and rejecting a fair gamble. For a risk-neutral agent, we can write the vN{M utility function of wealth simply as: $U = W$ it is a straight line.



Risk loving

A risk-loving agent, on the other hand, prefers a risky bet to a safe alternative when they have the same expected outcome. In other words, a risk-loving agent would prefer to accept a fair gamble. The graph below shows, for a risk-loving agent, the CE of a gamble is higher than the expected value of the gamble. Certainty Equivalence in this case, is you would have to pay a risk-loving agent to give up a risky gamble in favour of the safe alternative of getting the expected value of the gamble.



4.7 ACTIVITIES

1. A risk-averse individual is offered a choice between a gamble that pays 1000 with a probability of 1/4, and 100 with a probability of 3/4, or a payment of 325. Which would they choose? What if the payment was 320?
2. Jen has narrowed her employment decision own to twochoices.one job I very safe (there is no chance of getting hurt at work),whereas the other job is rather dangerous (there is 20percent chance of being seriously injured. The safe job pays $10,000. The risky job pays $R
   a. Suppose that Jens preferences can be represented by a vNM utility function of the form $U = 20 - \frac{20{,}000}{c-\delta}$ where c is her consumptionin dollars and $\delta = 1$if she is injured and $\delta = 0$ if she is not injured. What is the expected utility of the safe job and the dangerous job?
   b. What is the minimum amount of R that would induce Jen to take the dangerous Job?
   c. Suppose the safe job now pays $20,000, What is the minimum amount of R that would induce Jen to take the dangerous Job?

4.8 SUMMARY

We have looked at;

- A person in an uncertain environment is choosing among contingent commodities whose value depends on the eventual outcome.
- A risk averse person will not accept an actuarial fair bet.
- Risk averse people buy insurance
- People seek to maximize the expected value of their utility.

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5.0 UNIT FOUR: THEORY OF A FIRM

5.1 INTRODUCTION

In this unit we look at the dynamics of how firms make a decision on what quantity to produce, how much cost to incur and how much profit to make.

5.2 AIM

The aim of this unit is to introduce you to the concept of decision making from the view point of the firms that produce goods and services.

5.3 OBJECTIVES

At the end of this unit you should be able to do the following

- Derive the optimal amount of output to produce.
- explain the concept of isoquant and iso-cost
- Calculate marginal rate of technical substitution, elasticity of substitution.
- Derive the profit maximizing output
- Derive the Shepard’s lemma duality concept

5.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

5.5 REFLECTION

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Think of you starting up a firm, what would you require to run it successfully?

5.6. READINGS

Varian

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 7and 8

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing

PRODUCTION FUNCTIONS

The relationship between inputs and output is expressed by the production function ,which shows the maximum amount of output that is produced with the given amount of inputs.

$$q = f(k,l)$$

The marginal product is the amount of output produced by employing and extra unit of an input.

$$MPL = \frac{dq}{dl}$$

$$MPK = \frac{dq}{dk}$$

The law of Diminishing marginal productivity states that, assuming technology is fixed, successive units of a variable resource are added to a fixed resource (capital or land) beyond some point the extra unit of output attributed to the additional unit of a variable input will decline. Marginal product will start to fall as more labour is added to a fixed unit of capital. the concept of diminishing marginal productivity is a short run concept. In the short run one input is variable while the other is constant.

$$\frac{dMPL}{dl} = \frac{d^2q}{dl^2} < 0$$

$$\frac{dMPK}{dk} = \frac{d^2q}{dk^2} < 0$$

Average productivity of labour is the output per unit of labour. The average amount of output each unit of labour employed is producing.

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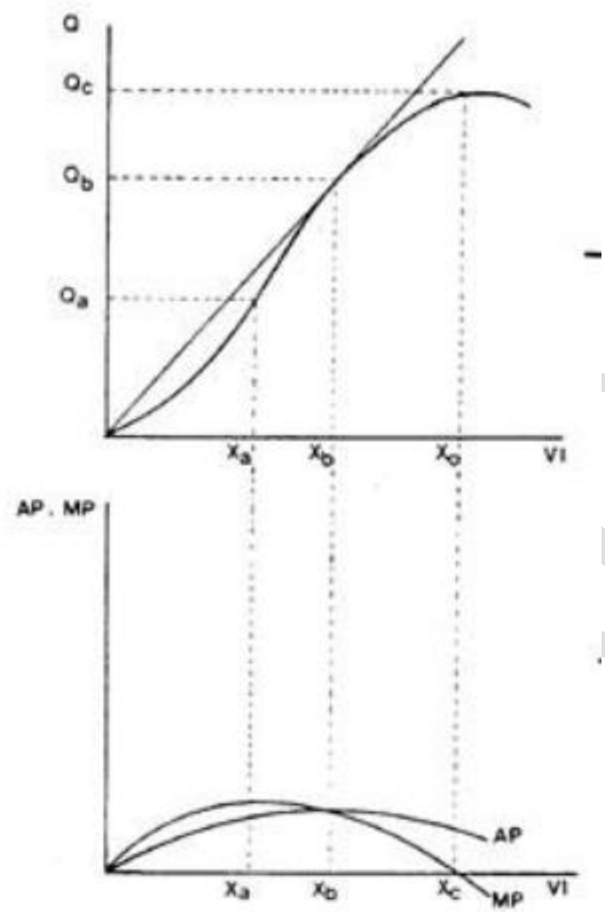
The graph below shows the relationship between total product, marginal and average product curves. This illustrates the average-marginal rule where when a marginal value is less than an average value, the average is falling and when the marginal value is greater than average value, the average is rising. When the two are equal, the average is constant - which implies that the average should be at a maximum or minimum point

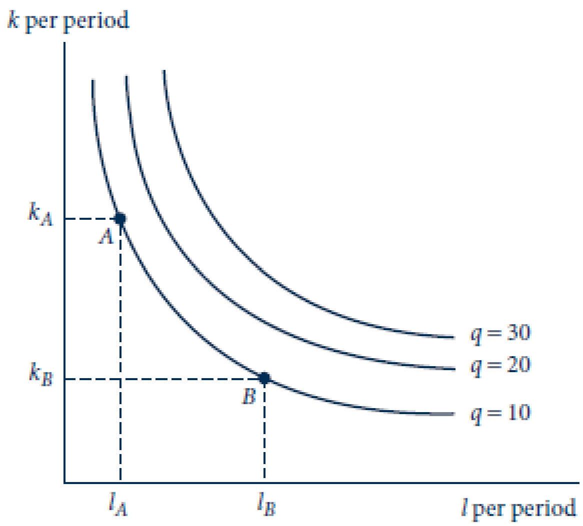


When labour employed is less than X_a, marginal and average are increasing and marginal reaches its maximum at X_a. when labour employed is between X_a-X_b marginal product is falling while average product reaches its maximum at X_b. between X_b-X_c both cures are falling and marginal is zero at X_c.

In the long run both inputs are variable; therefore we will have to vary both labour and capital to produce a given amount of output. An isoquant is a locus of points that show a combination of capital and labour that produce a given amount output. the graph below shows an isoquant map.

Lets pick the first isoquant q=10. We use K_A and L_A to produce q=10 and we can still use K_B and L_B to produce the same amount of output q=10.

The slope of the isoquant gives as a marginal rate of technical substitution (MRTS). It shows the rate at which labour is substituted for capital to produce a given output level. MRTS is diminishing for successive increase in labour. this is because for high k/l ratio more capital is given up and lower k/l small units of capital are given up.



source; Nicholson&Snyder

$$MRTS = \left.\frac{dk}{dl}\right|_{q0}$$

$$dq = \frac{\partial q}{\partial l}dl + \frac{\partial q}{\partial k}dk = 0$$

$$\frac{dk}{dl} = -\frac{\partial q}{\partial l} \div \frac{\partial q}{\partial k}$$

$$\frac{dk}{dl} = -\frac{MPL}{MPK}$$

Returns to scale show how much output will change when you increase inputs. constant returns to scale is when a proportionate increase in inputs results in a proportionate increase in output. Increasing returns to scale is when a proportionate increase is in inputs results in a more than proportionate increase in output. Decreasing returns is when a proportionate increase in inputs results in a less than proportionate increase in output.

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Effect on Output	Returns to Scale
$f(tk, tl) = tf(k, l) = tq$	Constant
$f(tk, tl) < tf(k, l) = tq$	Decreasing
$f(tk, tl) > tf(k, l) = tq$	Increasing

COST FUNCTIONS

We are using labour and capital in the production, therefore we incur a cost based on how many units of capital and labour we employ. The total cost function is given by

$$C = wL + rK$$

Where w is the wage rate and r is rent for capital.

Marginal cost is the cost incurred to produce an extra unit of output.

$$MC = \frac{dC}{dq}$$

Average cost is the the cost per unit of quantity.

$$AC = \frac{C}{q}$$

In the short run one variable is fixed, therefore short run costs consists of fixed cost and variable cost. Fixed costs are those that do not pertain to production and since capital is fixed in the short run it is also part of the fixed cost.

$$C(q) = FC + VC$$

$$AC = \frac{FC}{q} + \frac{VC}{q}$$

$$MC = \frac{dVC}{dq}$$

Total cost curve has the same shape as the variable cost curves since fixed cost are constant.

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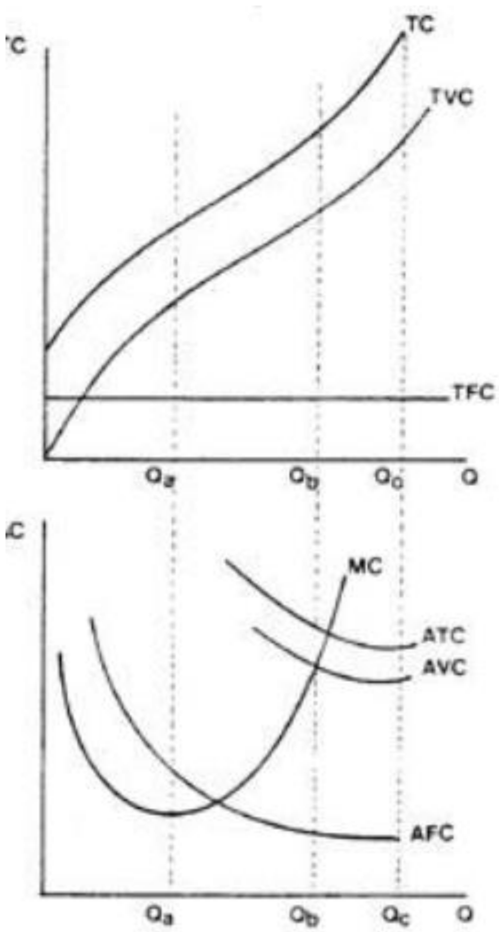
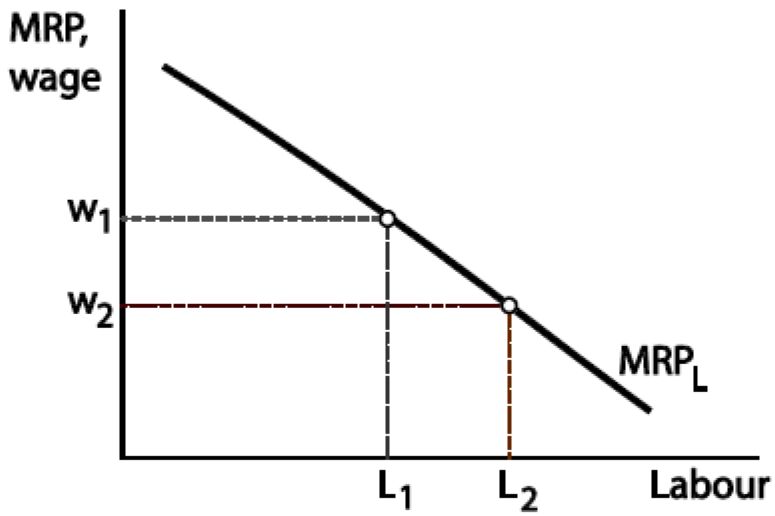


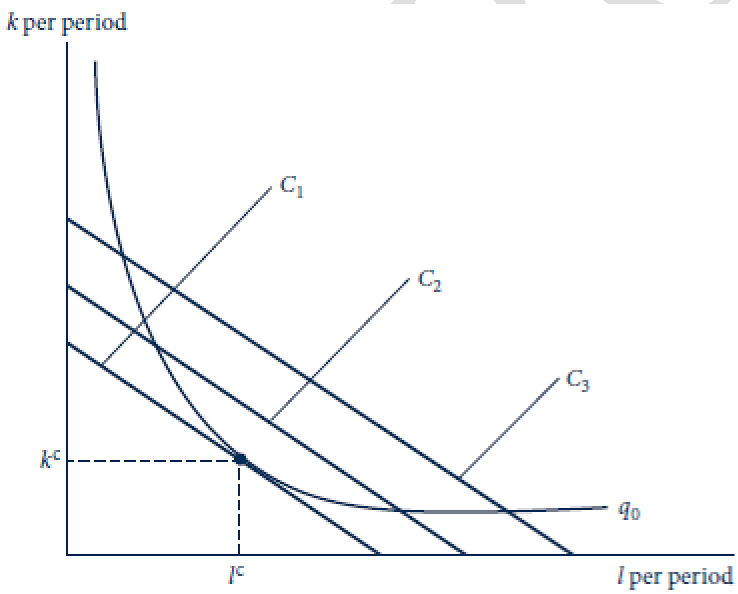
In the short run since capital is fixed, labour is the only input used in production, therefore to know how much labour is needed we look at employing a unit of labour. One unit of labour employed will produce MPL of output. A unit of output sold will increase revenue by MR,there the total revenue realized from employing the unit of labour is MPL*MR. this is the marginal revenue productivity of labour. Since a unit of labour cost a wage rate of w. then a firm will continue employing labour for as long as the revenue contribution of each unit of labour is equal to the cost of employing that same unit of labour.

$$w = MPL \times MR$$
$$w = MRPL$$

This gives the demand for labour. When the wage rate fall more labour will be employed because the cost of employing and additional unit of labour is law. This is shown in the figure below.



In the long run when all inputs are variable then we can vary the amount of capital and labour that can give us a minimum cost. Iso-cost lines are lines recording the amount of capital and labour that give us the same level of cost. With a given level of cost we can try to maximize the amount of output to produce or vice versa with a given output we can minimize the cost to produce it. This is the tangency been an iso-cost and isoquant.

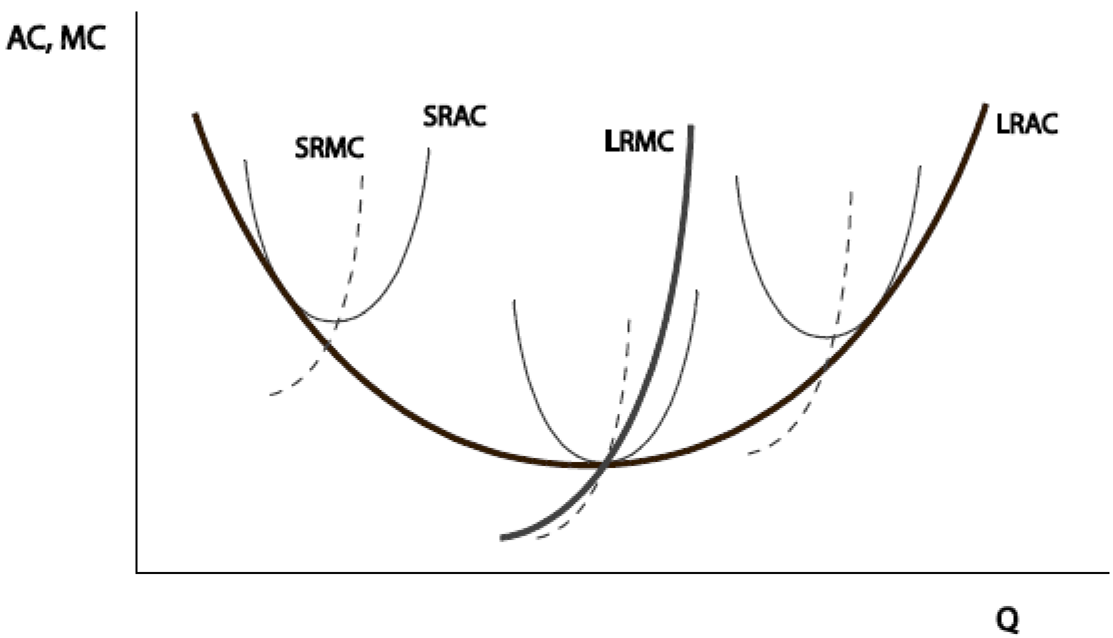


This tangency can be derived using a langreage function.

Min $wL + rK$ subject to $q_0 = f(k,l)$

$$\ell = wL + rK + \lambda(q_0 - f(K,L)$$
$$\frac{d\ell}{dl} = w - f_l^{'} = 0$$
$$\frac{d\ell}{dk} = r - f_k^{'} = 0$$
$$\frac{d\ell}{d\lambda} = q_0 - f(K,L) = 0$$
$$MRTS = \frac{MPL}{MPK} = -\frac{w}{r}$$

The long-run average cost curve (LRAC) is an envelope of the short-run average cost curves (SRACs). the long-run average cost is lower than the minimum short-run average cost over the region where the firm experiences increasing returns to scale. This is the region where the LRAC is falling. Similarly, over the region where the LRAC is increasing, the firm experiences decreasing returns to scale and, again, the LRAC is lower than the minimum of the SRAC. the minimum point of the SRAC is also the minimum point of the LRAC. Note also that the LRMC is flatter, i.e. more elastic, compared to the SRMC.



Example

Consider the production function

$$Q = L^{0.5}K^{0.5}$$

In the short run,k is fixed k=100. W=25 and r=8.

Derive the short run and long run cost functions.

$$L = \frac{Q^2}{\overline{K}}$$

$$C = wL + rK$$

$$C(Q) = w\frac{Q^2}{\overline{K}} + r\overline{K}$$

$$C(Q) = \frac{Q^2}{4} + 800$$

This is the short run cost function in terms of Q.

To derive the long run cost, we need to minimize cost subject to quantity. Use the langreage function. The optimal point is the tangency between isoquant and iso-cost line.

Shepard's lemma duality concept tells us that getting a derivatives of the short and long run cost functions gives us the input demand functions

If we have a production function

$$Q = L^{\alpha}K^{\beta}$$

$$MRTS = \frac{\alpha K}{\beta L} = \frac{w}{r}$$

$$K^{c}(r,w,q) = Q^{\frac{1}{\alpha+\beta}}\left(\frac{\alpha}{\beta}\right)^{\frac{\alpha}{\alpha+\beta}} w^{\frac{\alpha}{\alpha+\beta}} r^{-\frac{\alpha}{\alpha+\beta}}$$

$$L^{c}(r,w,q) = Q^{\frac{1}{\alpha+\beta}}\left(\frac{\alpha}{\beta}\right)^{\frac{\beta}{\alpha+\beta}} w^{\frac{-\beta}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}}$$

$$C(r,w,q) = (r,w,q) = Q^{\frac{1}{\alpha+\beta}} B w^{\frac{\alpha}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}}$$

$$B = (\alpha+\beta)\alpha^{\frac{-\alpha}{\alpha+\beta}}\beta^{\frac{-\beta}{\alpha+\beta}}$$

The long run cost function above is derived to get

$$\frac{dC(r,w,q)}{dw} = L^{c}(r,w,q)$$

$$L^{c} = \frac{\alpha}{\alpha+\beta} Q^{\frac{1}{\alpha+\beta}} B w^{\frac{\alpha}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}}$$

$$\frac{dC(r,w,q)}{dr} = K^{c}(r,w,q)$$

$$K^{c} = \frac{\beta}{\alpha+\beta} Q^{\frac{1}{\alpha+\beta}} B w^{\frac{\alpha}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}}$$

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Profit maximization

Maximum profit is obtained from getting the largest difference between revenue and cost. The graph below shows that profit is largest at Q=6, at this point the slope of the total cost function is equal to the slope of revenue function. MR=MC

Any profit maximizing output is at point where MR=MC

Marginal revenue is inversely related to elasticity of demand.

$$MR = \frac{d(p*Q)}{dQ} = p + q\frac{dp}{dq}$$

$$Elasticity = \frac{dq}{dp}\frac{p}{q}$$

$$MR = p(1 - 1/e)$$

This implies that if

$e > 1 \rightarrow MR > 0$

$e < 1 \rightarrow MR < 0$

$e = 1 \rightarrow MR = 0$

Shut down decision

In the short run, a firm continues to operate even if revenues do not cover all costs. If fixed costs on equipment such as plants and machinery have been incurred, this cannot be altered in the short run. So the short-run shut-down decision pays no attention to fixed costs and only considers if the firm is covering its variable costs. The firm should continue to operate so long as it covers its variable costs. In other words, the firm shuts down production in the short run

if: P < AVC:

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In the long run all factors are variable. Therefore, the firm shuts down if it cannot cover all its costs even at the minimum level of LRAC. In other words, a firm shuts down in the long run if:
P < LRACmin:

5.7 ACTIVITIES

1. Consider a firm with production function$Q = K^{\alpha}L^{\beta}$. The wage rate is w, and the rental rate of capital is r. Calculate the short-run optimal cost as a function of α, β input prices w; r and Q.
2. Consider a firm with production function $Q = K^{\frac{1}{2}}L^{\frac{1}{2}}$ The wage rate is w, the rental rate of capital r. Derive the long-run cost function of the firm.

5.8 SUMMARY

We have looked at;

- Economic theory states that a firm acts to maximise profits
- Economic cost is measured by opportunity cost
- Optimal output is determined when marginal revenue is equal to marginal cost
-

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6.0 UNIT FIVE: MARKET STRUCTURE

6.1 INTRODUCTION

In this unit we look at the types of market structures an economy has. We will show how a firm has influence in the market. In the extreme case of perfect competition a firm has no influence on market forces. In a monopoly, the firm has the influence over the entire market supply.

6.2 AIM

The aim of this unit is to study the behavior and outcome of a firm under perfect competition and monopoly. The analysis is done under a partial equilibrium.

6.3 OBJECTIVES

At the end of this unit you should be able to do the following;

- Calculate the profit maximizing output in each market
- analyze the impact of entry and exit decisions of firms and their impact on industry supply under perfect competition
- analyse price discrimination under monopoly

6.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

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6.5 REFLECTION

Have you ever wondered why in some industry there are so many players and other have few?

6.6. READINGS

Varian

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 10, 11, 13.

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing

PERFECT COMPETITION

To determine any market we need to understand number and relative strength of buyers and sellers, degree of freedom in determining price, level and forms of competition, extent of product differentiation, and ease of entry into and exit the market.

Therefore, perfect competition has the following characteristics

1. a large number of firms, each firm has a small market share
2. free entry and exit, and
3. a relatively homogeneous product, the products are identical
4. price takers
5. buyers and sellers know the prices and the nature of the product.

Since firms are price takers they face a perfectly elastic demand function. It is horizontal at the price prevailing in the market. The price is set by forces of demand and supply in the market thus a single firm has to use the price as its demand function.

The firm profit maximizing output is at a point where MR=p=MC. Thus in the short run a firm can make normal profits, zero profits and losses. If a firm is making abnormal profits, it attracts new entrant into the market and the share away all the profits. If it is making a loss, other firms will leave the market and market share increases thus reducing the loss.

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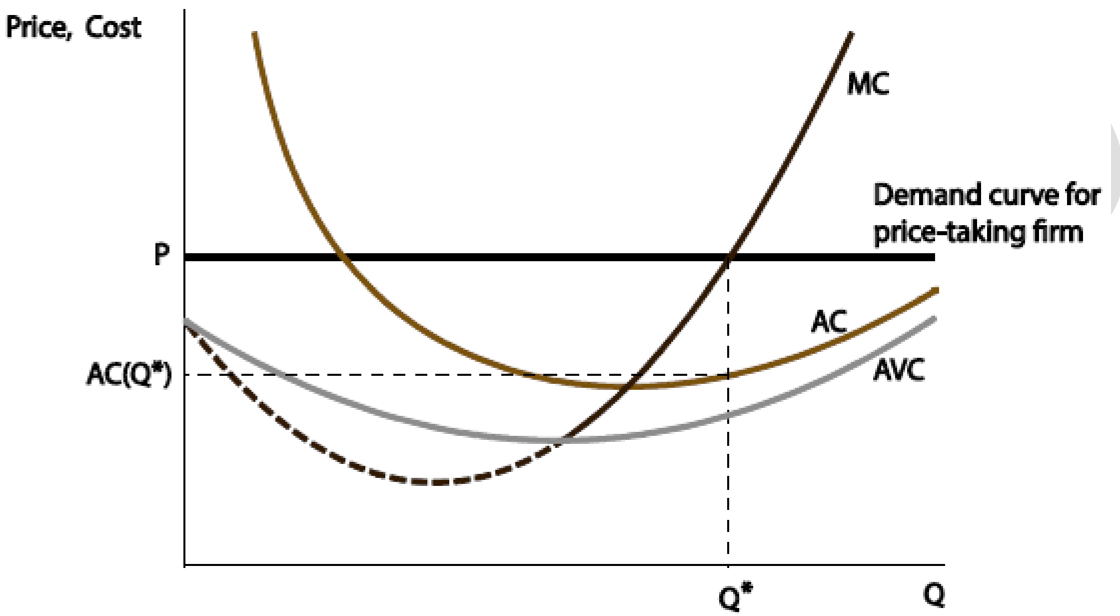
The graph below shows a firm that is maximizing at Q* and P. since P> AC at Q*the firm is making abnormal profits equal to (P-AC)Q. if P<AC at Q*, the firm would be making a loss but if P=AC, they are just breaking even.



Short run supply curve.

The short run supply curve is the marginal cost curve above the average variable cost. This is because any change in price leads to a new output produced by the firm at a point where P=MC. Therefore we can trace out combinations of prices and quantities that a firm is willing and able to supply. The market supply curve is the summation of all individuals firms supply to the market. This is because each firm uses the same market price to determine how much they produce.

Example

Suppose a firm has the following cost functions and they are 100 firms in the market. Find the short run supply functions.

$$C(Q) = 100 + 10q - 6q^2 + q^3$$

$$MC = 10 - 12q + 3q^2$$

$$AVC = 10 - 6q + q^2$$

We need to determine the minimum point on the AVC curve. We do this by differentiating AVC function and equating to zero.

$$\frac{dAVC}{dq} = -6 + 2q = 0$$

$$q = 3$$

$$AVC = 1$$

The minimum point is where AVC is 1. So the supply function is given as

$P = 10 - 12q + 3q^2$ for $P \geq 1$

Market supply is the summation of individual firms supply

$$P = \sum_{1}^{100} \left(10 - 12q + 3q^2\right)$$

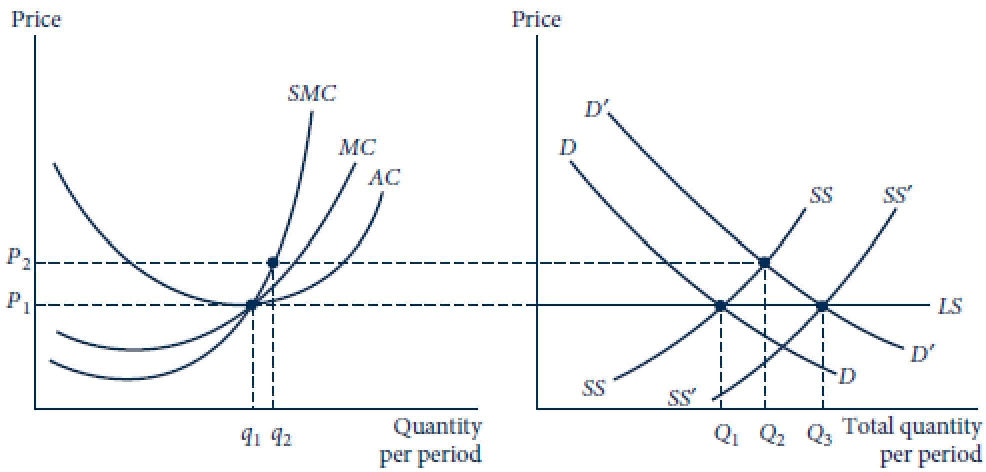
$$P = 100\left(10 - 12q + 3q^2\right)$$

Long run supply curve

In the long run, all firms that where making profits or losses will break even. This is because of free entrance and exit into the market. Entry will continue until all profits are shared away and everyone is breaking even. Exit will continue until all losses are no more. Since profit maximising point is P=MC, in the long run it is P=AC. Price should be equal to the minimum point of the average cost curve.The market supply curve as usual is the summation of individual firms supply.

The entrance and exit of firms in the market has an effect on the pricing of the firms input in the market.they can cause the pricing of input not to change,or they can increase or decrease. If input prices do not change when more firms enter the market we call this a constant cost industry. If input prices increase then it is an increasing cost industry. If the input price decreases it is a decreasing cost industry.

We analyse the long run supply curves in each cost industry.



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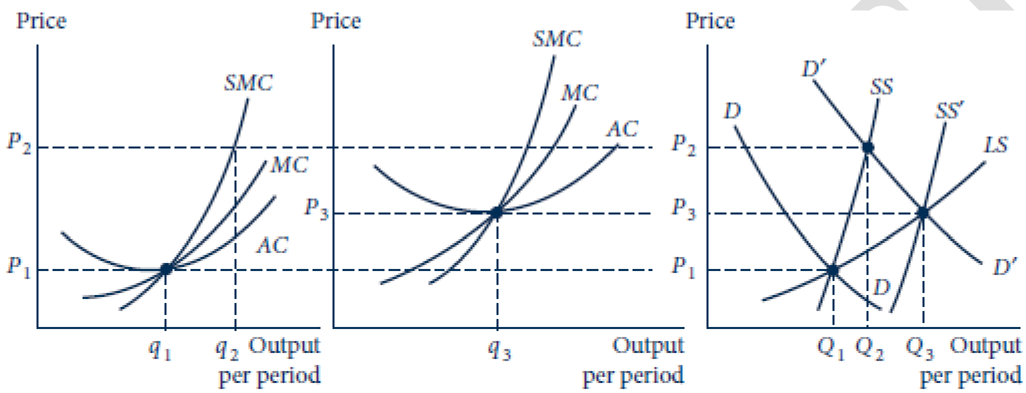
The graph above shows the case of a constant cost industry. We are in the long run where we are breaking even and there is no incentive for any firm to enter. We suppose that there is a shift in the market demand function so that D shifts to D’. in the short run price increases to P_2 and firms are making profits. This attracts new firms to enter and it increases supply in the market thus the supply curve shifts downwards. The price goes back to P_1 and no firms enter the market. Joining the two long run position we have a long run market supply curve that is horizontal.

In an increasing cost industry,new firm cause input prices to increase. This implies that the cost curves will shift upwards.



(a) Typical firm before entry (b) Typical firm after entry (c) The market

From the graph the firm and the market are in equilibrium at P_1. Demand shifts upwards and cause price to increase to P_2. This increase in price causes an increase in the profits of the existing firms. Thus, new firms enter the market and input prices increase. This will cause a shift in the cost curves as can be seen in (b). the increase in costs and the new entrants cause the supply curve to shift downwards to new equilibrium at price P_3. At this new price no firm are entering and all firms are getting zero profit. It is a long run position. We join all long run position we have a long run industry supply curve that is upward sloping.

In a decreasing cost industry, new firms cause input prices to decrease. The cost curves will shift downwards. The long run industry supply curve is downward sloping.

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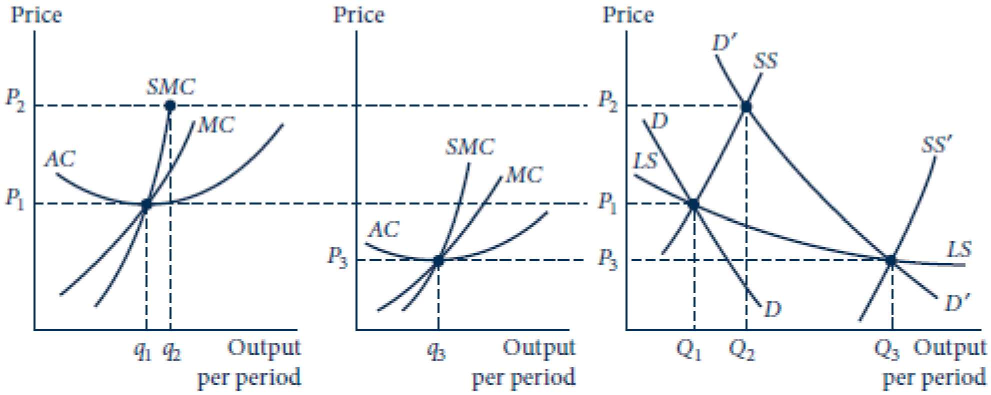
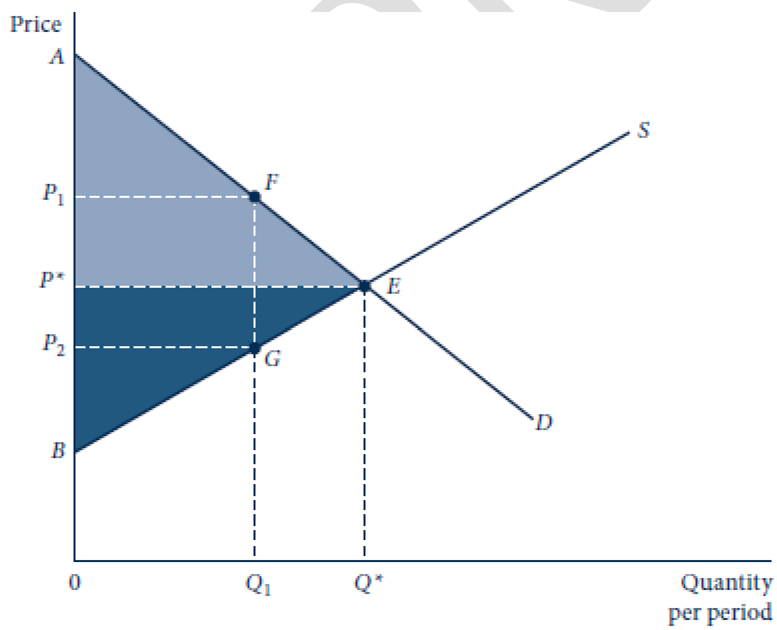


(a) Typical firm before entry (b) Typical firm after entry (c) The market

Producer surplus is the extra return that producers make by making transactions at the market price over and above what they would earn if nothing were produced. Itis the size of the area below the market price and above the supply curve. **Consumer surplus** is the extra utility consumers receive from choosing to purchase a good voluntarily rather than being forced to do without it. It is the area below the demand curve above the price. In the graph consumer surplus is given by the area AEP* and producer surplus is given by P*EB. If instead of q* being supplied in the market, Q1 is. At Q1 consumers are willing to buy at price P1 and whilst marginal cost are equal to P2

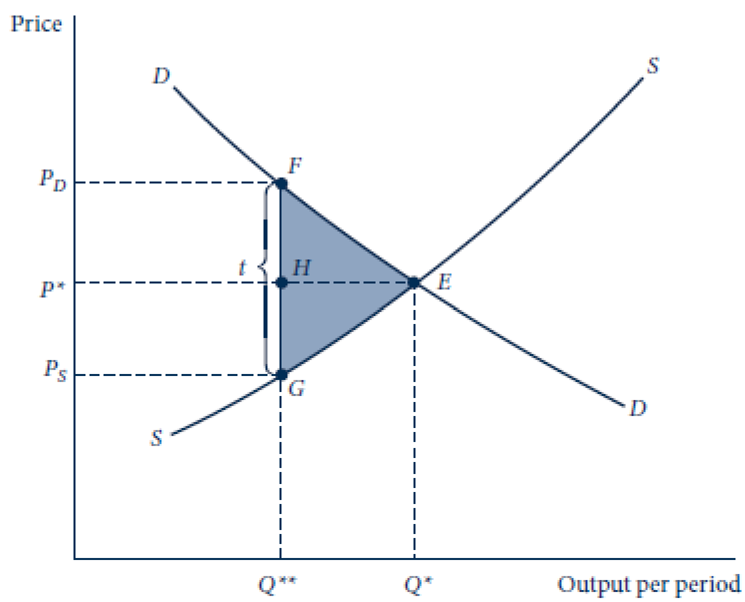


This reduces consumer surplus to area AFP1 and producers gain because surplus is now P1FGB. The total loss in surplus is FEG which is called the deadweight loss.

Price controls

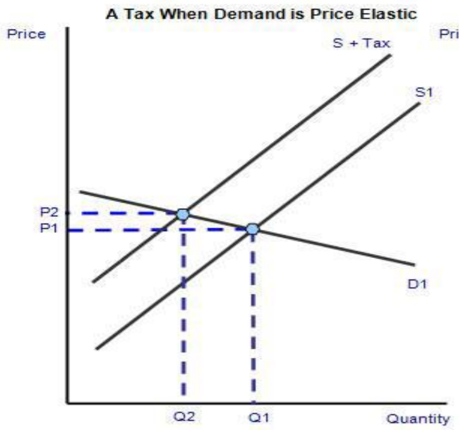
Government can control price through a tax and subsidy policy on producers, it can also control by imposing either price ceiling or price floor. These policies however bring the deadweight loss. Whenever a deadweight loss arises it means there is a loss in welfare because consumers and producers lose.

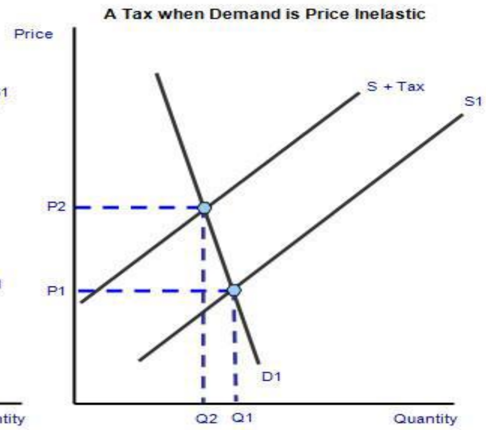
When government impose a tax on producers this affects the supply curve as the cost of production increases. The supply curve shifts upwards by the amount of the tax and equilibrium is at a higher price.in the diagram below a new equilibrium is at point F and price is P_D. consumers are paying FH towards the tax and producers are paying HG towards the tax. Government receives P_DFGP_S as tax revenue. Consumer surplus and producer surplus have been reduced by the amount paid in tax plus the area FEG which is the deadweight loss.



Tax incidence

Who pays more of the tax between consumers and producers? This depends on whose elasticity is inelastic. If demand is inelastic consumers will pay a larger amount of the tax. If demand is elastic, consumers pay a smaller amount of the tax.





Example

Suppose the (inverse) demand function in a market is given by P = 20- 2Q, and the (inverse) supply curve is P = 2 + Q. Suppose the government imposes a per-unit tax of t = 6 on suppliers. Calculate the incidence of the tax, the impact on consumer and producer surplus, the tax revenue and the deadweight loss from the tax.

Before tax, the market equilibrium quantity is 6, and the equilibrium price is 8. After tax, for any quantity, the price rises by t, i.e. the inverse supply curve shifts up by the extent of the tax, so that it becomes P = 2 + Q + t. In this case, P = 8 + Q. The new market equilibrium quantity is 4, and the equilibrium price is 12.

Consumers pay an extra 4 per unit. Therefore, the incidence on consumers is 4 per unit. The suppliers receive 12, but pay 6 to the government per unit so they receive a net-of-tax price of 6 per unit, 2 lower than before tax. Thus the incidence on suppliers is 2 per unit. Note that the demand curve is less elastic than the supply curve, hence the difference in incidence.

Consumer surplus before tax $CS = \frac{1}{2}(20-8)6 = 36$ and producer surplus is $PS = \frac{1}{2}(8-2)6 = 18$. Total surplus is 54. After tax $CS = \frac{1}{2}(20-12)4 = 16$ and $PS = \frac{1}{2}(6-2)4 = 8$. Total surplus is 24. Government revenue is 6*4=24. $DWL = \frac{1}{2}(12-6)(6-4) = 6$

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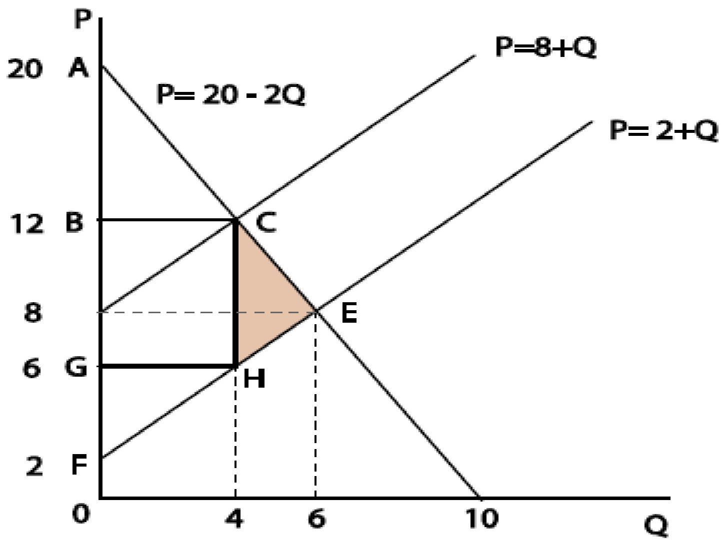
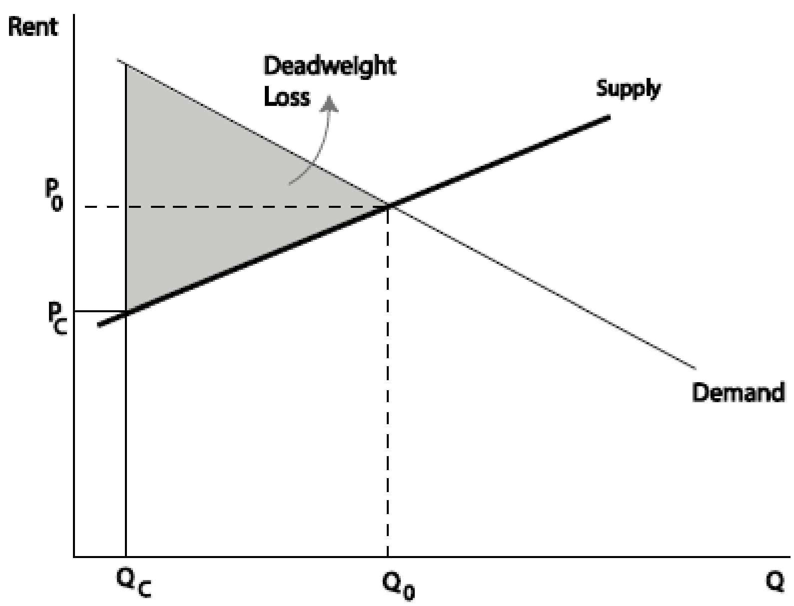


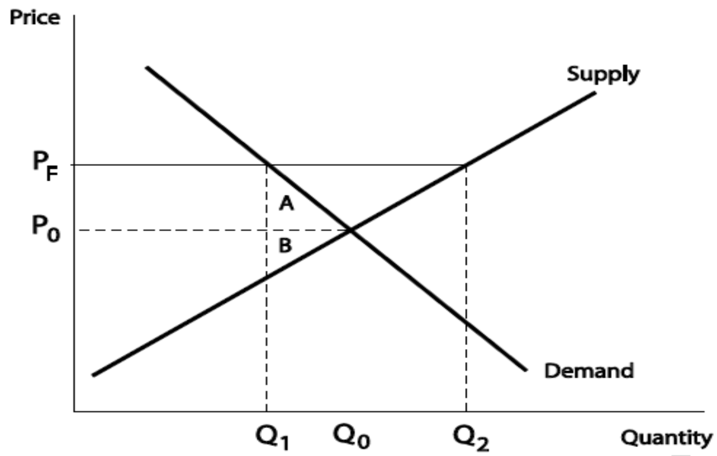
Price ceiling is the maximum price that should be charged for a commodity. The price is set below equilibrium. A good example is rent controls, if there is a ceiling no one should set a price higher than the ceiling but anything below is welcome.



The graph shows that price ceiling brings a deadweight loss, because sellers will only supply Qc at price Pc. The price has created excess demand that has resulted in consumers losing welfare. Producers also loss welfare because the loss by supplying less.

Price floor is the minimum amount that is charged for a commodity. It is set above equilibrium.a good example is minimum wage. No price is set below the price floor but anything above is

welcome. At price Pf consumers buy less than what suppliers are supplying. This causes excess supply and suppliers lose revenue from what has not been sold. Consumers pay a higher price and lose some surplus. A deadweight loss of A+B exists.



MONOPOLY

The characteristics of a monopoly

1. A single seller: the firm and industry are synonymous/the same.
2. Unique product: no close substitutes for the firm’s product.
3. The firm is the price maker: the firm has considerable control over the price because it can control the quantity supplied.
4. Entry or exit is blocked.

Barriers to Entry

“The reason a firm is alone in the market is because others find it unprofitable or impossible to enter. The barriers to entry give it monopoly power”(Nicholson and Snyder,p501)

Technical barriers- *Economies of scale is* the major barrier. This occurs where the lowest unit cost is attained at a high output. A very large firm with a large market share is most efficient, new firms cannot afford to start up in industries with economies of scale.

Another technical basis of monopoly is special knowledge of a low-cost productive technique. The monopoly has an incentive to keep its technology secret; but unless this technology is protected by a patent, this may be extremely difficult. Ownership of unique resources—such as mineral deposits or land locations, or the possession of unique managerial talents,may also be a lasting basis for maintaining a monopoly.

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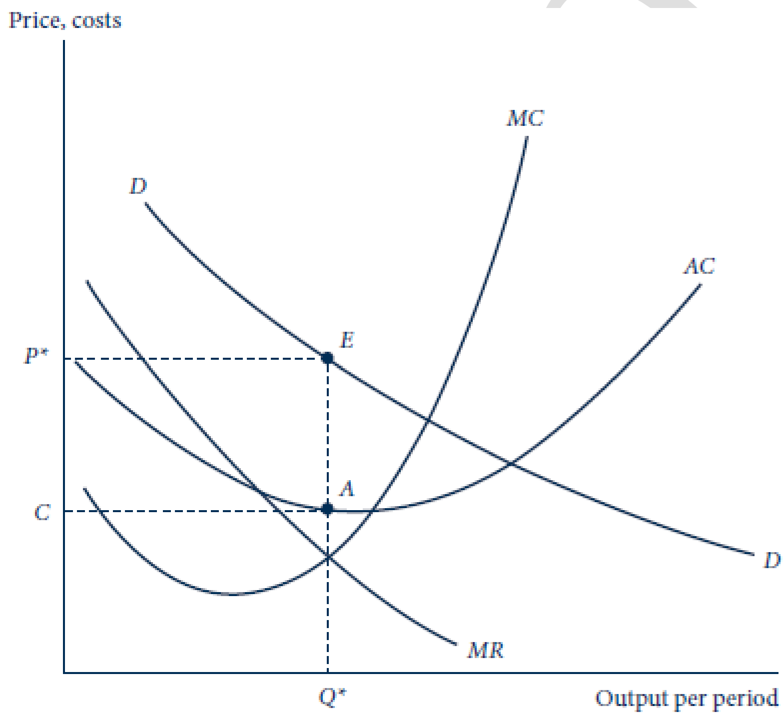
Legal barriers- these include patents and copyright. This is when government gives protection to the firm as the innovator of some technology in the production of a good. Patents and copyrights are given to profit innovation.

Another is government giving exclusive franchise to a firm to serve the market. This is common for public utility like electricity,water and sewerage

Profit maximization

A monopoly faces a downward sloping demand curve with a marginal revenue below it. This is because it has to lower the price for the units sold so as to generate extra demand to absorb the extra unit of the good. $MR = P\left(1 - \frac{1}{|\varepsilon|}\right)$. Therefore, a monopoly maximizes profit at the point where MR=MC, produces out Q* and charges price P*. The amount of profit made is P*EAC. This is because the price charged is higher than the average cost. Monopoly profits can exist even in the long run, however it may also break even in the long run.



source;Nicholson& Snyder, p503

Due to the marginal revenue function, the monopoly operates on the elastic part of the demand function because marginal revenue is high.

$$MR = P\left(1 - \frac{1}{|\varepsilon|}\right)$$

When ε>1 MR>0, ε=1 MR=0, ε<1 MR<0.

It is not rational to operate at the inelastic part because marginal revenue is negative.

Equating MR=MC yields a lerner index

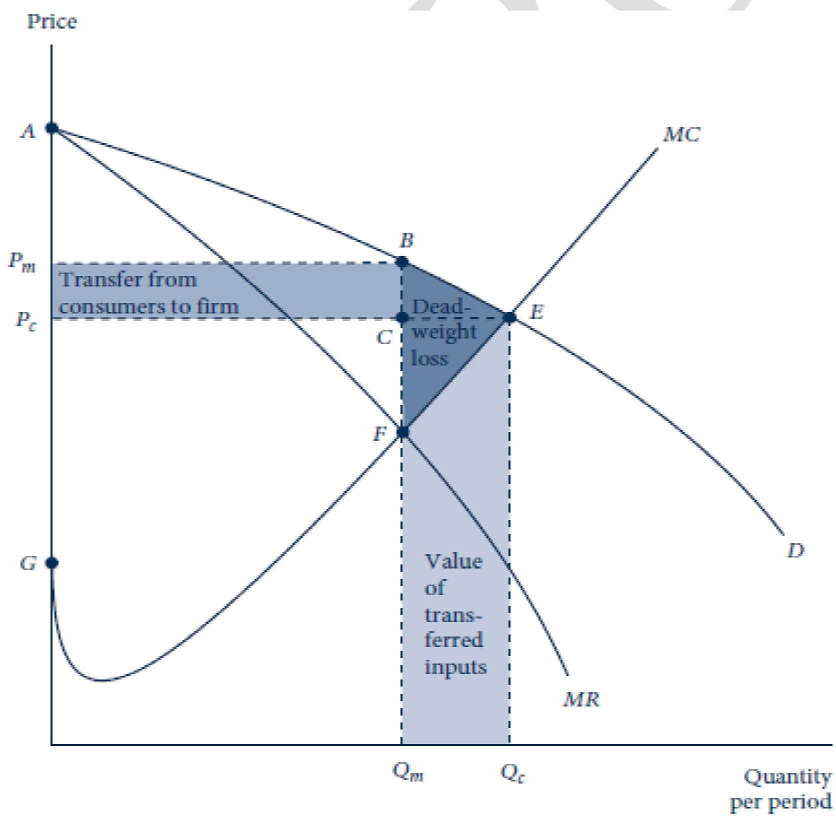
$$MR = P\left(1-\frac{1}{|\varepsilon|}\right) = MC$$

$$\frac{P-MC}{P} = \frac{1}{|\varepsilon|}$$

The price markup over marginal cost shows monopoly power in pricing. Assuming elasticity is constant on the demand curve the markup is also constant implying that price and MC are directly proportional. An increase in MC will increase price. As long as the demand curve facing the monopoly is downward sloping, upward shifts in MC will prompt the monopoly to reduce output and increase price.

We cannot trace out a monopoly supply curve from changing demand curves. This is because each demand curve is a unique profit-maximizing opportunity for a monopolist.

Monopoly and deadweight loss



We are comparing the monopolist and perfect competitions' profit maximizing output and price. Perfect competition maximizes at a point where P=MC which is point E on the graph. Consumer surplus is AEP_c. Monopolist maximizes at MR=MC with price P_M, consumer surplus is equal to ABP_M. A monopolist charges a higher price than a firm in a perfect competition. Thus a monopolist gets some of the consumer's surplus into its profit. This has resulted in a loss in welfare by both the producer and consumer which is called the deadweight loss (area BEF).

Price discrimination

This whole time we have assumed that the monopolist is charging the same price but in certain conditions it can increase its profit by charging different prices to different buyers. Price discrimination is selling a good or service at a number of different prices, and the price differences is not justified by the cost differences. In order to price discriminate, a monopoly must be able to

1. Be able to segregate the market. The monopolist must be able to segregate the buyers into distinct classes; each has a different willingness and ability to pay for the product. This is based on different price elasticities of demand.

2. Make sure that buyers cannot resell the original product or services. If the buyers in the low price segment are able to resell the product to the high price segment, the monopolist price discrimination strategy would create competition in the high price segment. This competition would reduce the price and undermine the discrimination policy.

There are three types of price discrimination; first degree, second degree and third degree price discrimination.

First degree price discrimination

According to Nicholson and Snyder (2011,P514) If each buyer can be separately identified by a monopolist, then it may be possible to charge each the maximum price he or she would willingly pay for the good. This strategy of perfect (or first-degree) price discrimination would then extract all available consumer surplus, leaving demanders as a group indifferent between buying the monopolist's good or doing without it.

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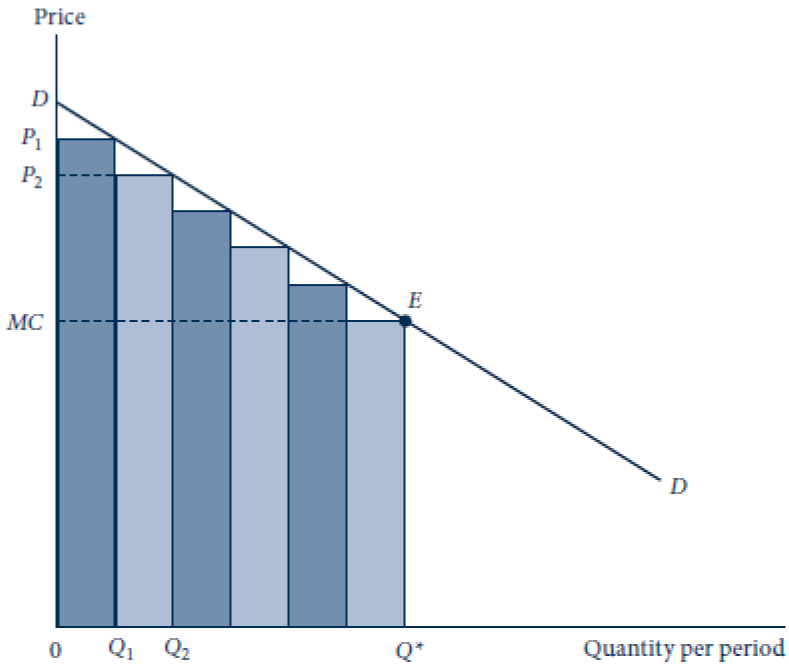

The monopolist is charging different prices for each quantity demanded. A consumer who demands Q_1 is charged P_1. If a consumer demands Q_2-Q_1 he is charged P_2. A firm will charge any price on the demand curve up until price reaches marginal cost. Consumers' surplus is exhausted.

Third degree price discrimination

The monopolist must separate buyers in two groups based on their elasticities of demand and their demand function. The firm faces the same marginal cost but equates it to the respective marginal revenues.

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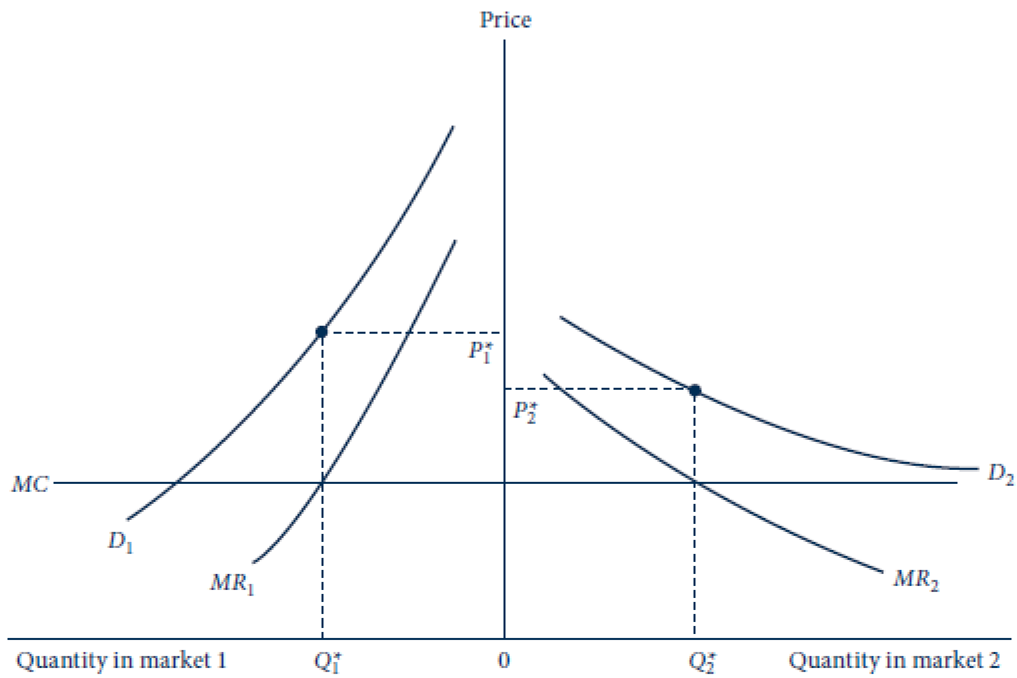

In the graph we have market one with an inelastic demand curve while market two is elastic. A firm set MR+MC for each market. Market one has a higher price than market two, this is because of their elasticity. Therefore we can conclude to say a market with inelastic demand pays a higher price than that which has an elastic demand. One this to note is that no resell should be possible between consumers from market2 to a consumer in market 1.

Second degree price discrimination.

Here, monopoly chooses a price schedule that provides incentives for demanders to separate themselves depending on how much they wish to buy. Such schemes include quantity discounts. The other scheme would be a two part tariff. A consumer is charged a fixed fee for the right to have the good and a price for a unit of a good consumed. Thus the total revenue called tariff from an individual is

$T(q) = a + pq$

Where a is a fixed charge and p is the unit price of a commodity. Now the decision to be made is what amount of a fixed fee and price is set. The fixed fee is set such that is is the maximum consumer surplus of an individual whose willingness to pay is low.

If we have two individuals the total tariff is

$T(q) = 2a + pq$

The total profit is

$\pi = 2a + (p - mc)Q$

this profit function is derived with respect to price, to find the fixed fee and price that will be charged.

Example

A monopolist has two customers with demand functions and MC=6

$q_1 = 24 - p_1$
$q_2 = 24 - 2p_2$

a) Now suppose the monopolist cannot differentiate between customers and must charge them the same price. Calculate the monopolist's optimal single price P as well as the quantity sold to each customer.
b) Suppose the monopolist can differentiate between customers, and customers cannot trade between themselves, allowing the monopolist to engage in third-degree price discrimination. What is the price charged to each consumer?
c) Suppose the monopolist cannot differentiate between customers. However, in addition to a per-unit price P, the monopolist can also charge a fixed fee F. A customer must pay this fee irrespective of the quantity purchased when a positive amount is purchased. Derive the monopolist's optimal price and fee.

Solution

a). if one price is charged to all customers, then we get the market demand function and calculate total revenue and marginal revenue and equate to marginal cost.

Total market demand is the summation of individual demand.

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$$Q = q_1 + q_2 = 48 - 3p$$

$$P = \frac{48 - Q}{3}$$

$$TR = P \times Q = Q\left(\frac{48 - Q}{3}\right)$$

$$TR = \frac{48Q - Q^2}{3}$$

$$MR = \frac{dTR}{dQ} = \frac{48 - 2Q}{3}$$

$$MR = \frac{48 - 2Q}{3} = 6 = MC$$

$$48 - 2Q = 18$$

$$Q = 15$$

$$P = 11$$

b) third degree price discrimination

$$P_1 = 24 - q_1$$

$$P_2 = 12 - \frac{1}{2} q_2$$

Calculate total revenue and marginal revenue for each individual

$$TR_1 = P_1 q_1 = 24q_1 - q_1^2$$

$$MR = 24 - 2q_1$$

$$MR = MC$$

$$24 - 2q_1 = 6$$

$$q_1 = 9$$

$$P_1 = 15$$

$$TR_2 = P_2 q_2 = 12q_2 - \frac{1}{2} q_2^2$$

$$MR = 12 - q_2$$

$$MR = MC$$

$$12 - q_2 = 6$$

$$q_2 = 6$$

$$P_2 = 9$$

c). two part tariff.

Customer 1s highest price he/she is wiling to pay is 24 while customer two is 12. Thus customer two has a lower willingness to pay than 1, thus we will set a fixed fee equal to customer twos consumer surplus.

$$CS_2 = \frac{1}{2}(12 - p)q_2$$

Total tariff will be $T(q) = 2a + pQ = 2CS_2 + pQ$

Total profit will be

$$\pi = 2a + (p - MC)Q = 2CS_2 + (p - MC)(q_1 + q_2)$$

$$\pi = 2\left(\frac{1}{2}(12 - P)(24 - 2P)\right) + (P - 6)(48 - 3P)$$

$$\frac{d\pi}{dP} = 0$$

$$\frac{d\pi}{dP} = (12 - P)\times -2 + (24 - 2P)\times -1 - 3(P - 6) + (48 - 3P) = 0$$

$$-24 + 2P - 24 + 2P - 3P + 18 + 48 - 3P = 0$$

$$2P = 18$$

$$p = 9$$

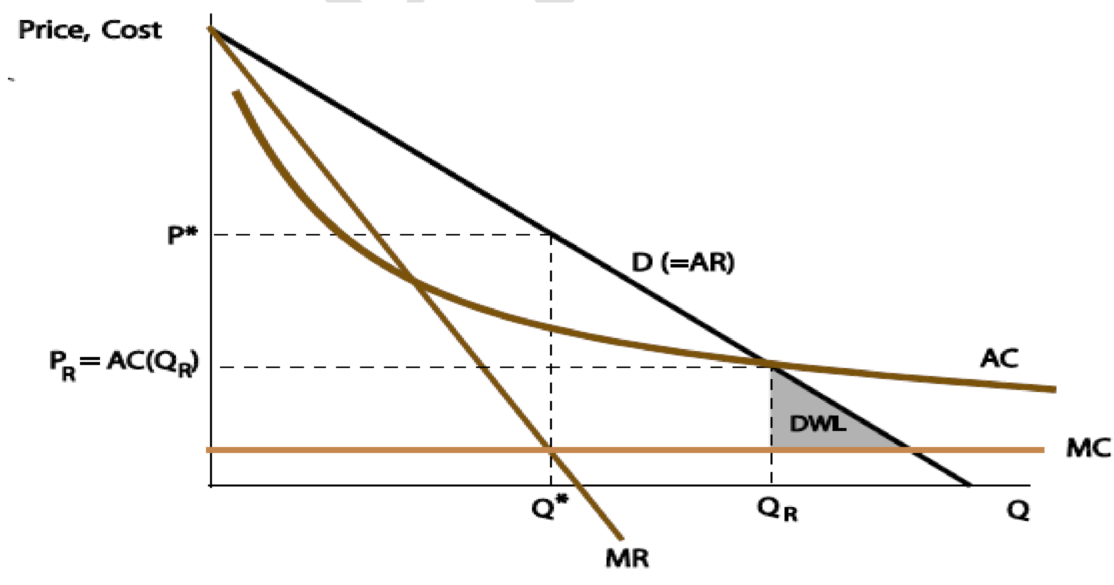
$$Q = 48 - 3(9) = 21$$

$$a = CS_2 = \frac{1}{2}(12 - 9)(24 - 2*9) = 9$$

The Monopolist will charge a fixed fee of 9 and price 9.

Natural monopoly

A natural monopoly will produce Q* and charge price P*. this price is too high and government wants to restrict the firm to produce the perfect competition output where P=MC . at this output average cost is higher than price, thus the firm is making a loss and will leave the market. Thus for government to ensure that the firm operates but charges a reasonable price, it will set price equal to average cost. At this price there is some deadweight loss incurred but it is smaller than when price is set at P*. therefore, regulating natural monopolist still has some deadweight loss.



6.7 ACTIVITIES

1. An industry comprises of n identical firms. The short-run cost function of a price-taking firm is given by $C(q) = 4q^2 + 100$. The market demand curve is $Q = 600-10P$.

   (a) Find the market equilibrium price and quantity.

   (b) Will there be entry or exit from this industry in the long run?

2. Suppose that a monopoly producer of widgets has a constant marginal cost of 6 and sells its products in two separate markets whose inverse demand functions are:

$P_1 = 24 - Q_1$ and $P_2 = 12 – 0.5Q_2$:

   (a) Calculate the profit-maximising price-quantity combinations in these two markets.

   (b) Calculate the monopolist's total profit.

   (c) Calculate the deadweight losses in the two markets.

6.8 SUMMARY

We have looked at;

- The market structure is based on the assumptions of (1) the seller being a price taker or maker,(2) entry into the market and (3)the number of sellers.
- A firm in a perfect completion faces a horizontal demand curve while in a monopoly it faces a downward sloping curve.
- A firm in perfect competition is able to charge one price while a monopoly is able to price discriminate
- Perfectly competitive equilibrium results in output that maximises total welfare
- Monopoly output does not maximize welfare. Monopoly has some deadweight loss

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7.0 UNIT SIX: GENERAL EQUILIBRIUM AND WELFARE ECONOMICS

7.1 INTRODUCTION

In this unit we look at how all markets are in equilibrium at the same time. Both the consumer and the producer are in equilibrium maximizing both utility and output at the same time.

7.2 AIM

The aim of this unit is to introduce you to the analysis of welfare in an exchange and production economy.

At the end of this unit you should be able to do the following

- Construct the Edgeworth box and trace the contract curve
- Calculate the equilibrium points
- Explain the two welfare theorem

7.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

7.5 REFLECTION

What is efficiency? Are all market players utility satisfied by a given

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prevailing price?

7.6. READINGS
Varian

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 12
Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing

2.7 General equilibrium in an exchange economy

In the previous chapter we looked at market equilibrium on one good in isolation, this is called **partial equilibrium. In general equilibrium** we are looking at equilibrium of all markets simultaneously. It gives a sense of how various pieces of an economy fit together to work as a whole.

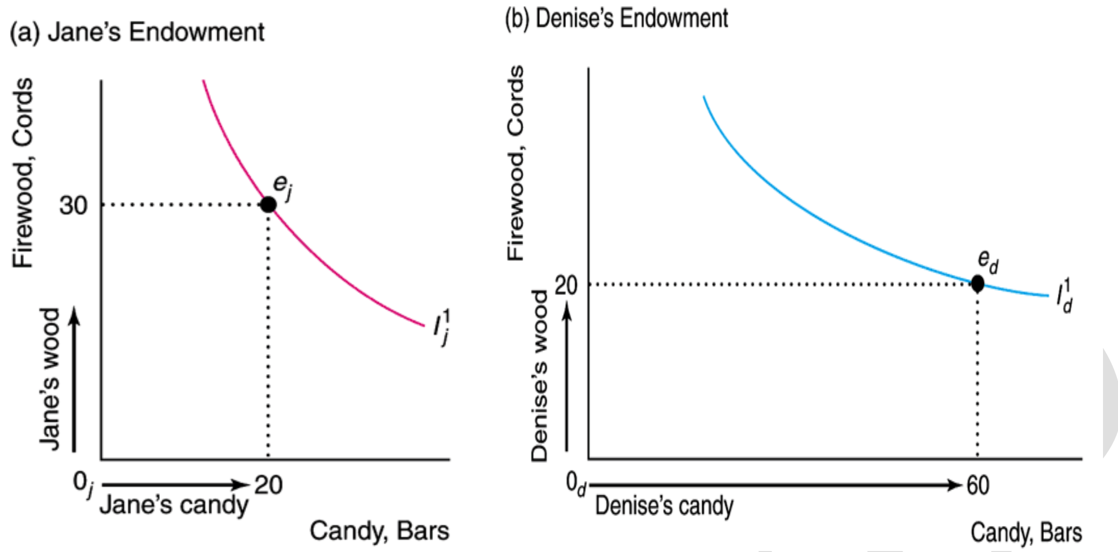
We suppose we have a large number of consumers (n>1) that have each a given endowment of a particular good (G>1). The demand for a commodity j for a individual i is x_j^i and e_j^i is the individual I's endowment for in good j. individual I's utility is given as $U_i(x_1,,,,x_g)$ and prices are $P_1,,,,,P_g$. The budget constraint is

$$P_1x_1^i + P_2x_2^i +++ P_gx_g^i$$

Every individual maximizes utility subject to a given budget constraint. All markets clear implying that demand should equal supply of the commodity.

We will limit our analysis to two consumers (A and B) and two goods(X and Y). we have two individuals Jane and Denise who have to trade with each other or they consume what they have at hand. Jane is endowed with 30 cords of firewood and 20 bars of candy, while Denise has 20 cords of firewood and 60 bars of candy. Altogether they have 50 cords of firewood and 80 bars of candy. Jane has more firewood than Denise, while Denise has more candy than Jane.

If they did not trade they consume their endowment and maximize utility with the given goods. We draw each of their indifference curves



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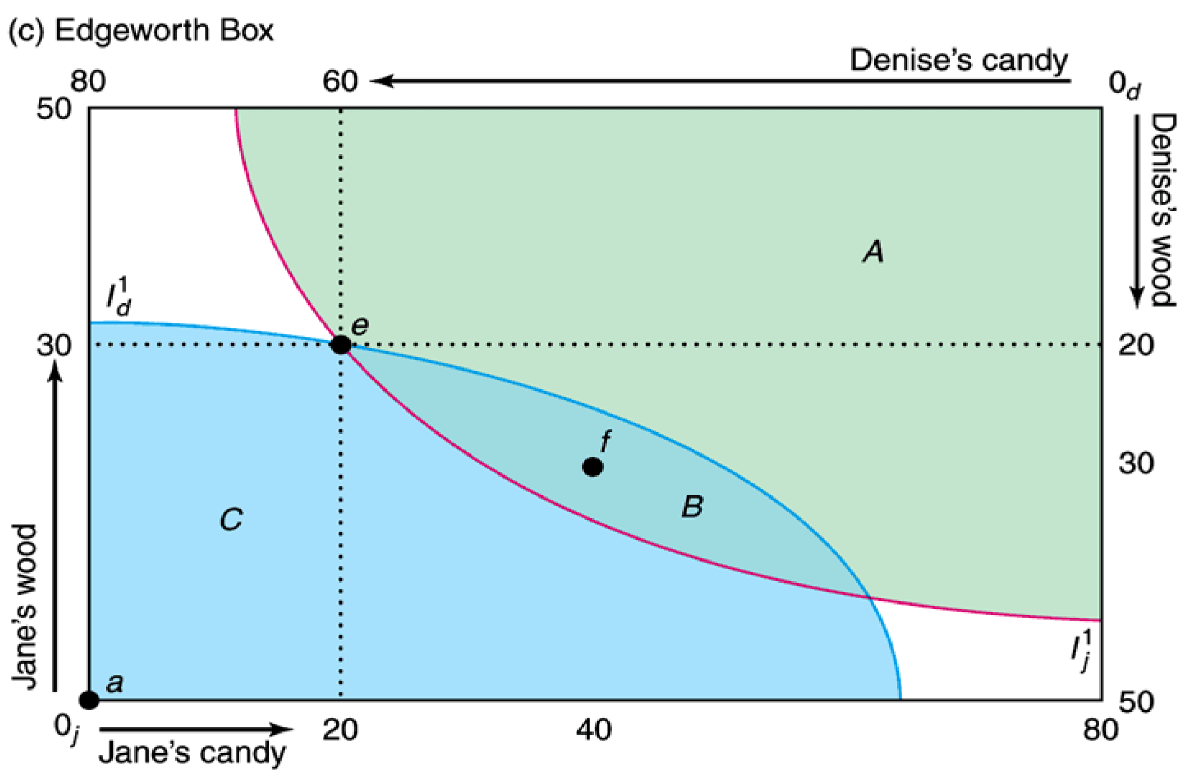
We will superimpose these two diagrams into one and we call it an Edgeworth box. It shows how we maximise utility for Jane and Denise simultaneously.



From the diagram above, Jane's origin is on the lower left denoted as O_j and Denise origin is on the upper right denoted as O_d. Jane's indifference curve is the red one while Denise is the blue

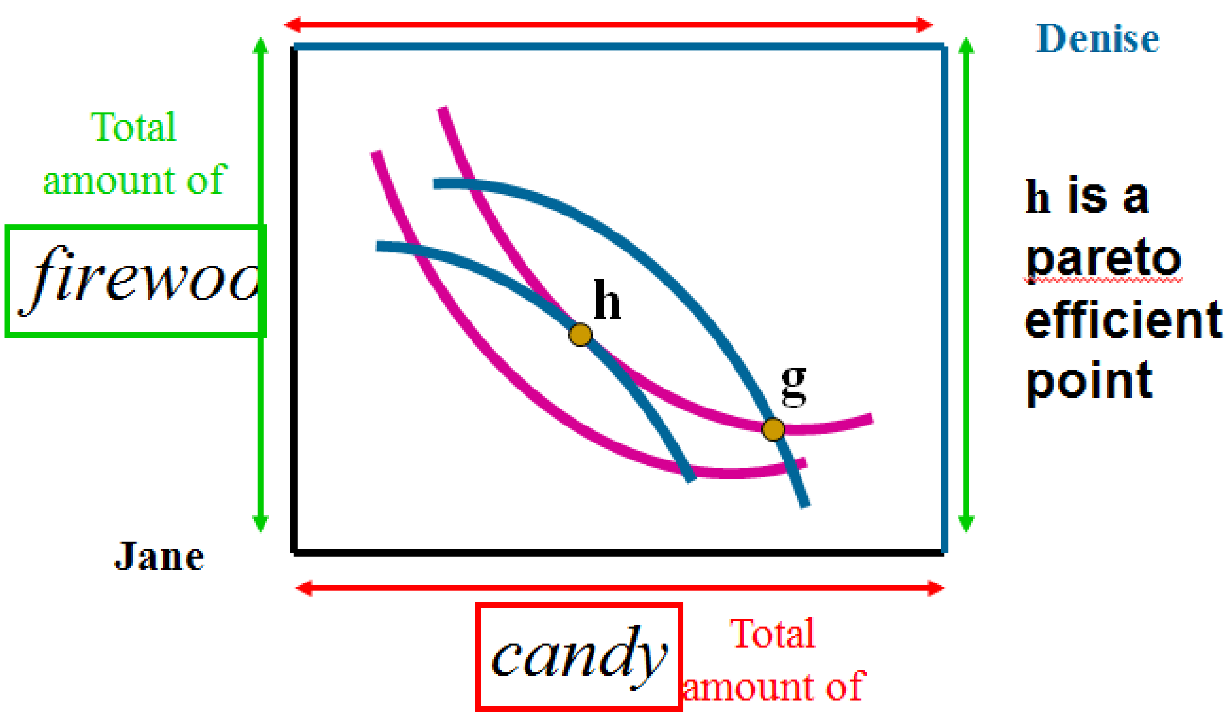
one. They are both convex to their origin. All properties of indifference curves will hold for each individual.

Jane will increase her utility for indifference curves that are in region B and A, while Denise will increase utility for indifference curves that are in region B and C. point e is the endowment point for both consumers. Point f in region B shows that both Jane and Denise could be on a higher indifference curve if the traded with each other.

Pareto efficiency; an allocation is pareto efficient if it is not possible to make one person better off without making the other worse off, given all supplies of the goods. **Pareto inefficiency** is when it is possible to make one person better off, without making the other person worse off.

Point in the Edgeworth box is pareto inefficient because there exists a point f where both consumers are better off.

The diagram below shows pareto efficient point



Point h is pareto efficient b it is not possible to make jane better of without making Denise worse off. A movement from point h will take us to a point where either jane or Denise will be on a higher indifference curve while either of them will be on a lower indifference curve.

Thus pareto efficient points are points of tangency between the two consumers indifference curves.

We can derive the pareto efficient points algebraically by maximising janes utility subject to Denises utility, total endowment of firewood and candy

Max $U_j(F_j, C_j)$ subject to $U_d(F_d, C_d) = \bar{u}$ and $F_j + F_d = \bar{F}$ and $C_j + C_d = \bar{C}$

Where $F_j + F_d = \bar{F}$ the total demand for firewood should be equal to the total endowment of firewood

$C_j + C_d = \bar{C}$ Is the total demand for candy which should be equal to total endowment of candy

$$\ell = U_j(F_j, C_j) + \lambda(U_d(F_d, C_d - \bar{u}) + \mu_1(\bar{C} - C_j - C_d) + \mu_2(\bar{F} - F_j - F_d)$$

$$\frac{d\ell}{dC_j} = \frac{dU_j}{dC_j} - \mu_1 = 0 \rightarrow (1)$$

$$\frac{d\ell}{dF_j} = \frac{dU_j}{dF_j} - \mu_2 = 0 \rightarrow (2)$$

$$\frac{d\ell}{dC_d} = \lambda\frac{dU_d}{dC_d} - \mu_1 = 0 \rightarrow (3)$$

$$\frac{d\ell}{dF_d} = \lambda\frac{dU_d}{dF_d} - \mu_2 = 0 \rightarrow (4)$$

Using equation 3 and 4 make λ the subject of the formula and put like terms together,

$$\lambda = \mu_1 \Big/ \frac{dU_d}{dC_d} = \mu_2 \Big/ \frac{dU_d}{dF_d}$$

$$\frac{\frac{dU_d}{dC_d}}{\frac{dU_d}{dF_d}} = \frac{\mu_1}{\mu_2}$$

using equation 1 and 2 we have

$$\frac{dU_j}{dC_j} = \mu_1$$

$$\frac{dU_j}{dF_j} = \mu_2$$

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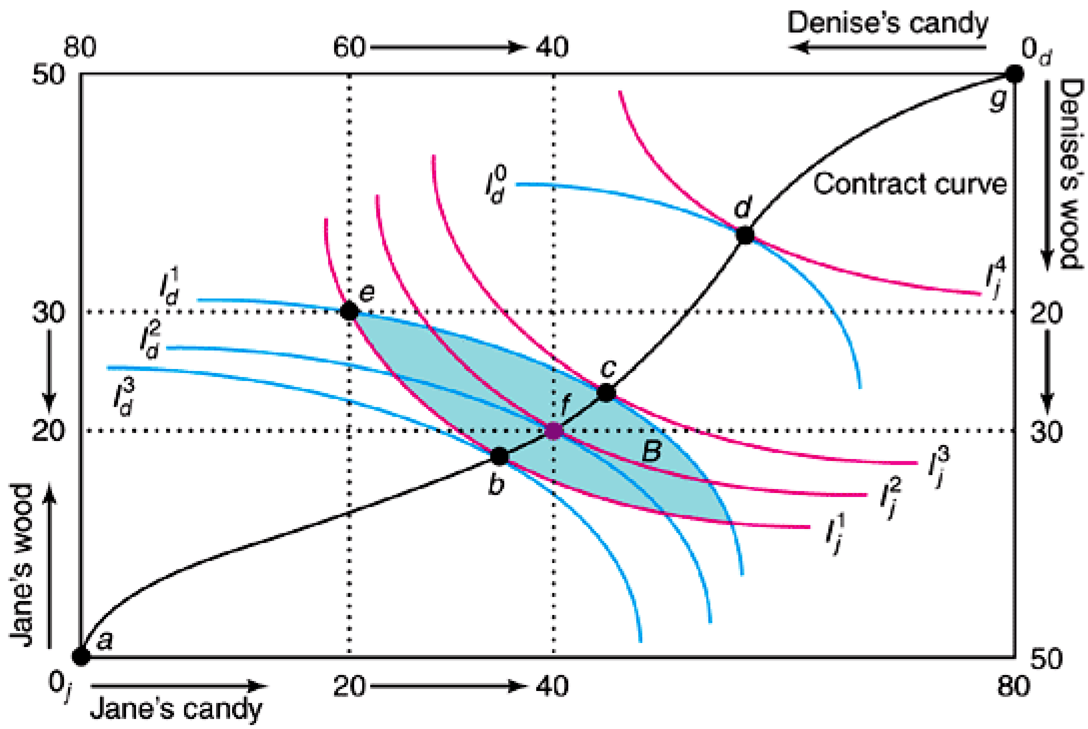
Combine we have

$$\frac{\frac{dU_d}{dC_d}}{\frac{dU_d}{dF_d}} = \frac{\mu_1}{\mu_2} = \frac{\frac{dU_j}{dC_j}}{\frac{dU_j}{dF_j}}$$

$$MRS_d = MRS_j$$

The diagram below shows the contract curve. A contract curve is the locus point that shows all pareto efficient points. Points b, f, c and d are pareto efficient so a line connecting them is a contract curve.



If they would trade and be at point f, Jane would give up 10 cords of firewood to get 20 bars of candy. Thus consume 20 of cords of firewood and 40 bars of candy. Denise would give up 20 bars of candy to get 10 cords of firewood, thus consuming 40 bars of candy and 30 cords of firewood. They are both better off than being at point e.

The point of tangency of indifference curves tells us that the slope of Jane's indifference curve is equal to the slope of Denise's indifference curve. Marginal rate of substitution for Jane is equal to Denise marginal rate of substitution.

$$MRS_j = MRS_d$$
$$\frac{MU_C^j}{MU_f^j} = \frac{MU_C^d}{MU_f^d}$$

If the price for candy and firewood are P_c and P_f respectively, then we can have their budget constraint.

Jane's and Denise's budget constraint should be such that whatever she consumes of candy and firewood should not exceed the value of their endowment.

$$P_c C_j + P_f F_j = P_c \overline{C}_j + P_f \overline{F}_j$$
$$P_c C_d + P_f F_d = P_c \overline{C}_d + P_f \overline{F}_d$$

C_j and F_j are Jane's demand for candy and firewood, $\overline{C}_j$ and $\overline{F}_j$ are Jane's endowment for candy and firewood while C_d and F_d are Denise's demand for candy and firewood, $\overline{C}_d$ and $\overline{F}_d$ are Denise's endowment for candy and firewood.

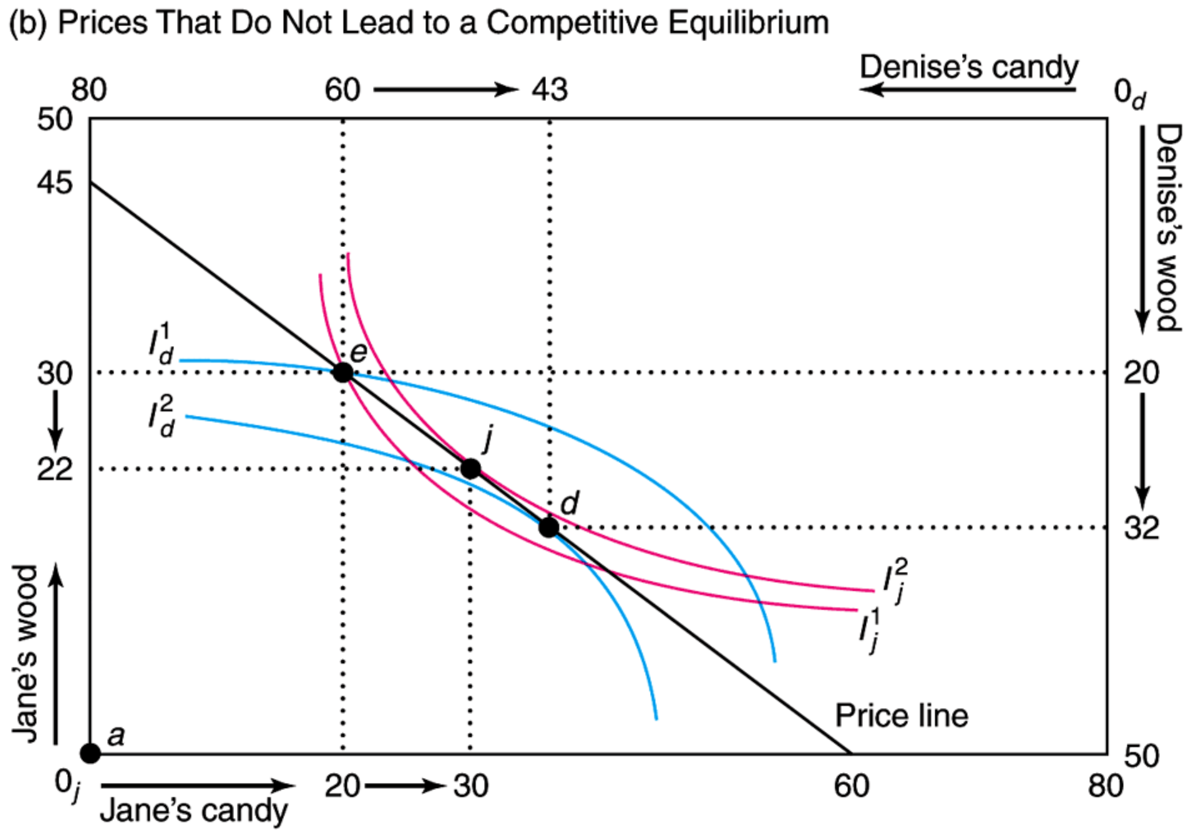
If the price for candy is 3 and price of firewood is 4 then we can know the value of their endowment which gives us their income

$$P_c C_j + P_f F_j = 180$$

$$P_c C_d + P_f F_d = 260$$

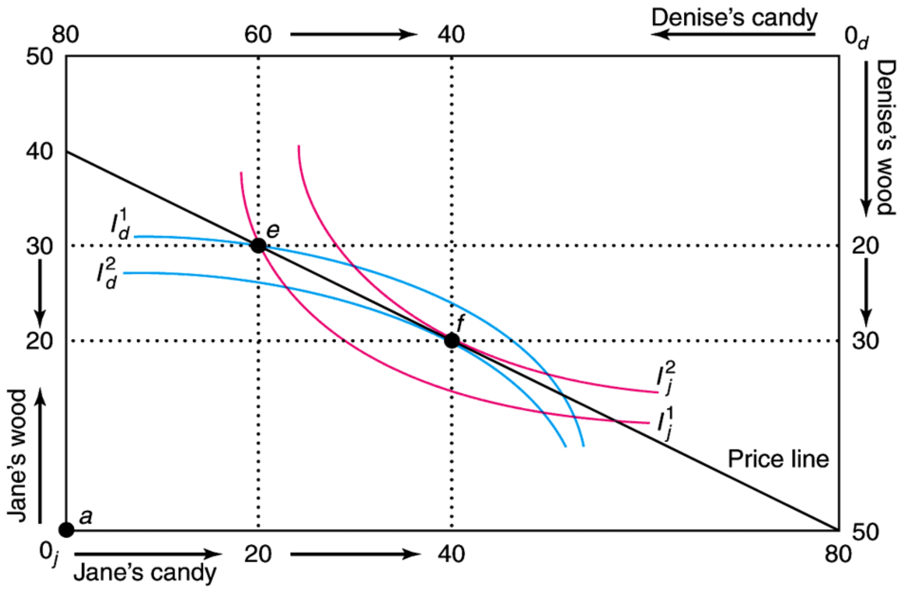
We draw a budget constraint in the Edgeworth box and find their optimal points. In the diagram below, jane maximises utility subject to budget constraint a point j and Denise at point d. at j jane is consuming 22 cords of firewood and 30 bars of candy, while Denise is consuming 43 bars of candy and 32 cords of candy. This shows that Denise is giving up 17 bars of candy and jane only buys 10 bars. This leaves 7 bars of candy unsold. We call this excess supply of bars of candy. Jane gives up 8 cords of firewood and Denise wants 12 cords. There is a short fall of 4 cords of firewood. This is called excess demand for firewood. The market for candy and firewood is not

in equilibrium because demand is not equal to supply in the respective markets. Thus prices for the commodities have not resulted in equilibrium. Thus the excess demand for firewood would push the price of firewood up and the excess supply of candy will lower the price of candy until all markets clear.



The budget line will become flatter showing that the price ratio has reduced.

(a) Price Line That Leads to a Competitive Equilibrium



The market clears at point f where price of candy 1 and price of fire wood 2. At point f both indifference curves are tangent to the budget constraint. At equilibrium marginal rate of substitution for Jane and Denise are equal to the price ratios

$$MRS_j = MRS_d = \frac{P_c}{P_f}$$

$$\frac{MU_C^j}{MU_f^j} = \frac{MU_C^d}{MU_f^d} = \frac{P_c}{P_f}$$

We have established equilibrium point to be the point where all curves are tangent to each other.

Example

The following are Jane and Denise's utility function consuming good X and Y.

$$U_j = X^{\alpha} Y^{1-\alpha}$$

$$U_d = X^{\beta} Y^{1-\beta}$$

Suppose their endowments are as follow; Jane ($\overline{X_j}, \overline{Y_j}$) and Denise $\overline{X_d}, \overline{Y_d}$

Find the equation for the contract curve and the equilibrium quantities and price.

Solution.

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$$MRS_j = MRS_d$$

$$\frac{MU_x^j}{MU_y^j} = \frac{MU_x^d}{MU_y^d}$$

$$\frac{\alpha X^{\alpha-1} Y^{1-\alpha}}{(1-\alpha) X^{\alpha} Y^{-\alpha}} = \frac{\beta X^{\beta-1} Y^{1-\beta}}{(1-\beta) X^{\beta} Y^{-\beta}}$$

$$\frac{\alpha Y_j}{(1-\alpha) X_j} = \frac{\beta Y_d}{(1-\beta) X_d}$$

$$X_j + X_d = \overline{X}$$

$$Y_j + Y_d = \overline{Y}$$

Replace Y_d and X_d with $\overline{Y} - Y_j$ and $\overline{X} - X_j$ respectively

$$\frac{\alpha Y_j}{(1-\alpha) X_j} = \frac{\beta(\overline{Y} - Y_j)}{(1-\beta)(\overline{X} - X_j)}$$

$$Y_j = \frac{(1-\alpha)\beta \overline{Y} X_j}{(\beta - \alpha) X_j + \alpha(1-\beta) X_j}$$

This gives the equation of a contract curve.

To find the equilibrium quantities we maximise each individuals utility subject to their own budget line.

By now we should be familiar with getting the demand functions. Just note that the budget constraints are given as

$$\begin{aligned} P_x X_j + P_y Y_j &= I_j \\ P_x X_d + P_y Y_d &= I_d \end{aligned} \quad \text{where} \quad \begin{aligned} I_j &= P_x \overline{X}_j + P_y \overline{Y}_j \\ I_d &= P_x \overline{X}_d + P_y \overline{Y}_d \end{aligned}$$

The demand functions are;

$$X_j^* = \frac{\alpha I_j}{p_x} \qquad X_d^* = \frac{\beta I_d}{p_x}$$

$$Y_j^* = \frac{(1-\alpha) I_j}{p_y} \qquad Y_d^* = \frac{(1-\beta) I_d}{p_y}$$

The market clears if total demand is equal to total endowments $X_j^* + X_d^* = \overline{X_j} + \overline{X_d}$ and $Y_j^* + Y_d^* = \overline{Y_j} + \overline{Y_d}$. So we add the demand function for jane and denise in the good X .

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$$\frac{\alpha I_j}{p_x} + \frac{\beta I_d}{p_x} = \overline{X_j} + \overline{X_d}$$

$$\frac{\alpha(P_x \overline{X}_j + P_y \overline{Y}_j)}{p_x} + \frac{\beta(P_x \overline{X}_d + P_y \overline{Y}_d)}{p_x} = \overline{X_j} + \overline{X_d}$$

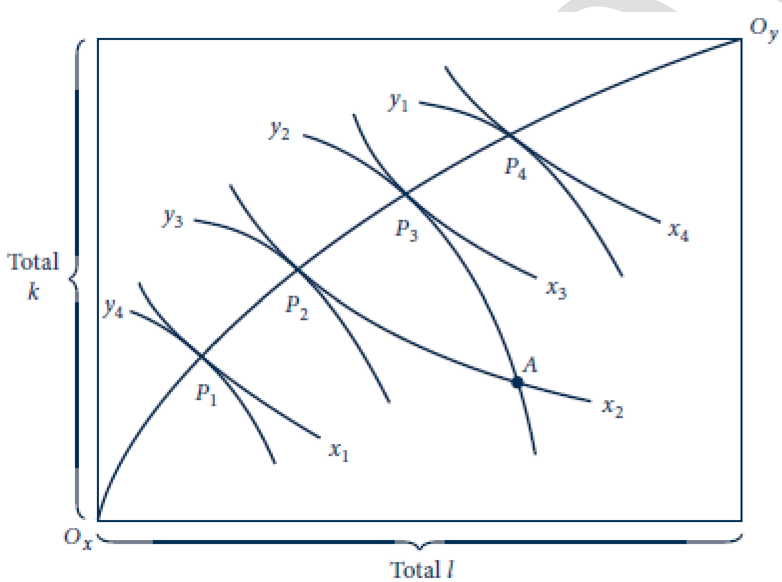
We have replaced I_d and I_j. now we let the price of y be $p = \frac{P_x}{p_y}$ and the price of x be 1.

$$\alpha(\overline{X}_j + P\overline{Y}_j) + \beta(\overline{X}_d + P\overline{Y}_d) = \overline{X_j} + \overline{X_d}$$

$$p = \frac{(1-\alpha)\overline{X}_j + (1-\beta)\overline{X}_d}{\alpha\overline{Y}_j + \beta\overline{Y}_d}$$

2.8 **production**

We want to express the general equilibrium analysis to production of two commodities X and Y using two inputs Labour and capital. The edgeworth box is shown below

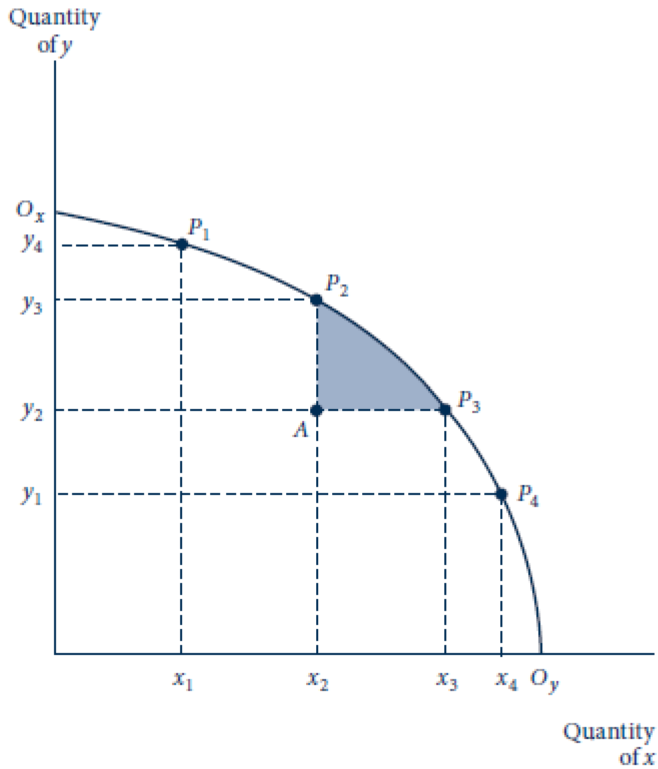


source; Nicholson and Snyder p460

We have two origins; O_x which the production of X and O_y which the production for Y. we have labour and capital on the x and y axis respectively. The isoquant for X and Y are convex to their origin. Pareto efficient points are points of tangency between the two isoquants. Point A is the endowment point of inputs. Thus, the contract curve gives a set of all pareto efficient points. This means that marginal rate of technical substitution of X is equal to marginal rate of technical substitution for Y.

$$MRTS_x = MRTS_y = \frac{w}{r}$$

When we draw the contract curve with X and Y on the axis we have a production possibility frontier that is concave to the origin



The production possibility frontier shows the alternative combinations of x and y that can be efficiently produced by a firm with fixed resources. The curve is derived by varying inputs between the production of x and y while maintaining the conditions for efficiency. The negative of the slope of the production possibility curve is called the rate of product transformation (RPT). We can pick on any production level of X and Y, this output will be sold in the market for exchange. Thus we introduce the budget line and the indifference curve. the three curves have to be tangent to each other in equilibrium. Implying that in equilibrium marginal rate of substitution is equal to marginal rate of technical substitution and price ratios

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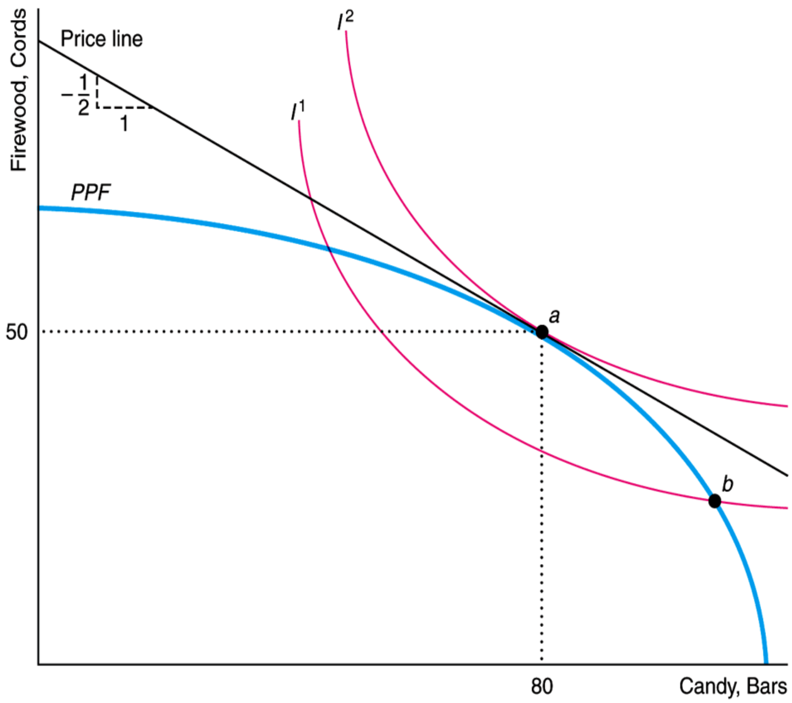
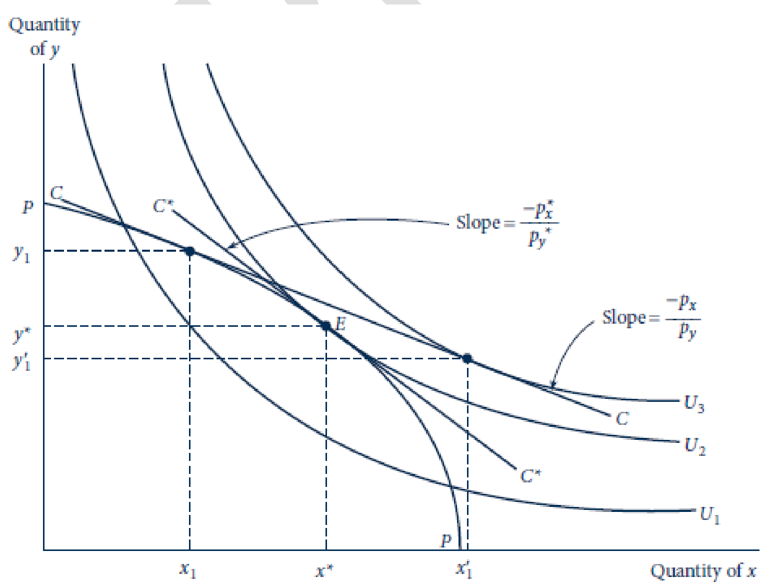


$$MRS = MRT = \frac{P_x}{P_y}$$

Since the slope of the PPF is different at each point on the curve then it means we face different prices to which we maximise utility.

Now what if the output level firms produce is not where consumers maximise their utility? The graph below illustrates what happens



With a price ratio given by px/py, firms will produce x_1 and y_1 ; society's budget constraint will be given by line C. however consumers maximize utility and demand x_1^* and y_1^*. This means there is an excess demand for good x and an excess supply of good y. The forces of demand and supply will move these prices toward their equilibrium levels p_x^* and P_y^* . At those prices, society's budget constraint will be given by line C*, and supply and demand will be in equilibrium. The combination x*, y* of goods will be chosen.

7.7 ACTIVITIES

1. Consider a pure exchange economy with two agents, Ann and Bob, who consume only two goods, x and y. In the economy there are 4 units of x and 2 units of y.

Ann is endowed with 1 unit of x and 2 units of y, and Bob is endowed with 3 units of x and 0 units of y. Their utility functions are:

$U_A = \sqrt{x_A y_A}$ $\qquad$ $U_B = x_B + 2y_B$

(a) Draw the Edgeworth box, showing the endowment point, and the indifference curves.

(b) Derive the contract curve.

(c) Derive the demand functions of the two agents.

(d) Calculate the exchange equilibrium price ratio.

(e) Calculate the exchange equilibrium allocation.

2. Romeo and Juliet inhibit a pure exchange economy with 10unitsof X and 20units of Y. Romeos utility function is $U^R = X^{\frac{1}{2}}Y^{\frac{1}{2}}$ and Juliet's is $U^J = X^{\frac{3}{4}}Y^{\frac{1}{4}}$ write down an expression of the contract curve

7.8 SUMMARY

We have looked at;

1. 1. For a set of prices to be consistent with general equilibrium, every firm must be maximising profits given its technology and every consumer must be maximising utility subject to his or her budget constraint
2. 2.pareto efficiency is described as an allocation which the only way to make one person better off is to make another worse off

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3. 3. First fundamental theorem of welfare economics, if all households and firms are price takers and there is a market for every commodity then the allocation of resources will be pareto efficient.

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8.0 UNIT SEVEN: GAME THEORY

8.1 INTRODUCTION

In this unit we look at how agents strategize in making their decision when they know about another agents strategy. In game theory, our analysis is playing a game and your interest is in checking what your opponents' next move is so that you know your move. In oligopoly we apply the technic of game theory in a market structure where every firm needs to strategize based on their assumption or full knowledge of what the other firm decides on producing to maximize profits.

8.2 AIM

The aim of this unit is to introduce you to the analysis game theory and its application. We will look at how agents will strategy when they have no information of what the other agent is deciding and we look at the analysis when one agent makes a move first while the other agent moves later. When also analyse how decisions are affected when the game is played once or when it is played infinite number of times.

At the end of this unit you should be able to do the following

- Identify dominant strategies or dominated strategies.
- Find Nash equilibria in pure strategies as well as Nash equilibria in mixed strategies in simultaneous-move games
- explain why Nash equilibrium is the central solution concept and explain the importance of proving existence
- Find Nash equilibria using backward induction and subgame perfection.

8.4 TIME REQUIRED

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Minimum amount of time on the unit is 2 hours

8.5 REFLECTION

You are playing chess with your friend, do you just touch a piece and move or you analyse what your friends move would be when you make a move?

8.6. ESSENTIAL READINGS

Varian

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 16

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and_extensions* (11th edition). Australia: South Western College Publishing

7. 1 simultanoeus move

A game is a situation where strategic behaviour is important for decision making. In a game we have players, strategy, actions and payoffs. A player is a decision maker who has the capability to choose between the set of actions available to him. A player can be an individual, a firm or a nation. We will look at a game with two players. Each course of action open to the player during the game is called a strategy. Example we have two players 1 and 2, individual one has to choose between UP and Down while individual two has to choose between Left or right. Thus 1's strategy is Up or Down while 2's strategy is Left or Right. Then if 1 chose Up and 2 chose Right {UP, LEFT} is a strategy profile, which is a listing of strategies chosen by each group of players. Thus we have 4 strategy profile ;{ UP, LEFT}, {UP, RIGHT}, {DOWN, LEFT} and {DOWN, RIGHT}

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Let S_1 denote the set of strategies open to player 1, S_2 the set open to player 2, and(more generally) S_i the set open to player i. Let $s_1 \in S_1$ be a particular strategy chosen by player 1 from the set of possibilities, $s_2 \in S_2$ the particular strategy chosen by player 2.

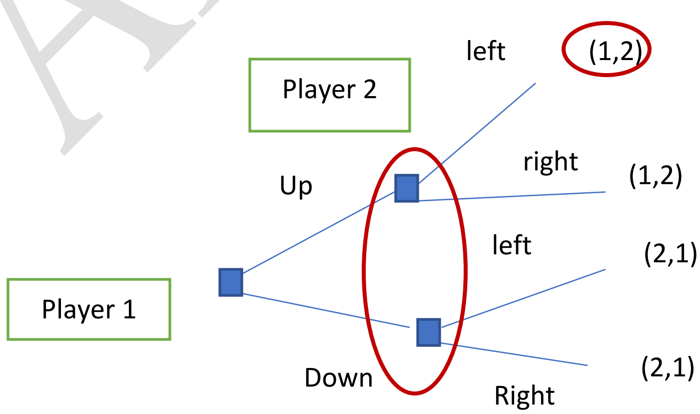
At the end of the game are payoffs, these can be in monetary form (e.g profit) or non-monetary terms (e.g utility, prestige). In a two-player game, $u_1(s_1, s_2)$ denotes player 1's payoff given that he or she chooses s_1 and the other player chooses s_2 and similarly $u_2(s_2, s_1)$ denotes player 2's payoff.1 The fact that player 1's payoff may depend on player 2's strategy (and vice versa) is where the strategic interdependence shows up. In an n-player game, we can write the payoff of a generic player i as $u_i(s_i, s_{\_i})$, which depends on player i's own strategy s_i and the profile $s_{\_i} = (s_1,\ldots, s_{i\_1}, s_{i+1},\ldots, s_n)$ of the strategies of all players other than i.

In our example we could have payoff for our set of possibilities which is U_1({ UP, LEFT})=U_1 ({UP, RIGHT})=1 and U_1({DOWN, LEFT})=U_1({DOWN, RIGHT})=2 and for player two we have U_2({ UP, LEFT})=U_2({UP, RIGHT})=2 and U_2({DOWN, LEFT})=U_2({DOWN, RIGHT})=1

We can put the payoff in a tabular form called the normal form or a tree diagram called the extensive game form.

		Player 2	
		Left	Right
Player 1	Up	1,2	1,2
	Down	2,1	2,1

In the table, the circled payoff show that first number is for player 1 and the second is for player 2. We show the extensive form;



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In the diagram we have decision nodes (coloured boxes) for player 1 and two. Player 1 has to action up and down while player two has left and right. The numbers at the end are payoffs , (see the circled one) implying that if player 1 chose up and player 2 chose left, player 1 gets 1 and player two gets 2. The circle around the decision nodes signifies that the two players do not know each other's decision. They are aware of the actions, strategies and payoff but they don't know what the other has decided to play. This is called a simultaneous game.

Dominant and dominated strategies

we will look at the prisoners' dilemma case were two suspects are caught in a crime. They are put in two separate rooms for interrogations and have two choices to make; to confess or not to confess. if one confesses while the other does not confess, they get a lesser sentence than the one who doesn't confess. If they both confess they get a stiffer punishment. They know if they both don't confess, the police will not have evidence to pin the down thus they will have a lesser sentence. They both don't know what decision the other will make. Below is the normal forn showing the payoffs

		Player 2	
		C	D
Player 1	C	$2,2$	$0,3$
	D	$3,0$	$1,1$

if they both confess they are sentenced to 2 years in prison and if they both don't confess they are sentenced to 1 year in prison. if one confesses he is set free while the one who doesn't confess goes in for 3 years.

lets say player one decides to confess, players two is better of confessing than not to confess. If player one decides not to confess player two is still better of confessing. Thus confessing is a best strategy for player two regardless of what player one decides. This is called his dominant strategy. **Dominant strategy is the strategy that gives the highest payoff regardless of the other player decides.** In this case it's the strategy that gives the lowest sentence regardless of what the other player does.

we turn to find player ones best strategy. Lets say player two decides to confess, player one is better of confessing than not to confess. If player two decides not to confess, player one is still

better of confessing. Thus confessing is also player ones dominant strategy. if each player plays their dominant strategy then {confess, confess} is the dominant strategy equilibrium.

a **dominated strategy** is one that gives a player the lowest payoff. A game might not have a dominant strategy but equilibrium can be found by eliminating dominated strategies and is called dominance solvable. Here is an example

		Player 2		
		Left	Middle	Right
	Top	4, 3	2, 7	0, 4
Player 1	Middle	5, 5	5, −1	−4, −2
	Bottom	3, 5	1, 5	−1, 6

let's start with player one, of the three strategies (top, middle and bottom), bottom is the one with the lowest payoff. Bottom is a dominated strategy and we eliminate it. For player two right is dominated and it is eliminated. So we now have top and middle for player one and left and middle foe player two. Top is dominated by middle thus it is eliminated. For player two, middle is dominated by left and we eliminate it. The remaining strategy is {middle, left}which is the equilibrium.

Nash equilibrium

An equilibrium is said to be a Nash equilibrium if it satisfies the two conditions;(1)nash condition that requires no player to be able to gain by changing their decision (2)credibility condition requires that every player makes a decision that is in his/her self-interest. Let look at the example that does not have dominant strategy equilibrium but has a Nash equilibrium.

		Player 2		
		A_2	B_2	C_2
	A_1	3, 1	1, 3	4, 2
Player 1	B_1	1, 0	3, 1	3, 0
	C_1	2, 3	2, 0	3, 2

No player has a dominant strategy but we look at player ones response to player two decisions.

Player 2's strategy	Player 1's best response
A_2	A_1
B_2	B_1
C_2	A_1

Player 2's best response:

Player 1's strategy	Player 2's best response
A_1	B_2
B_1	B_2
C_1	A_2

The Nash equilibrium is B_1B_2. If player 1 decides to move away from equilibrium and play A_1 or C_1, there is no payoff that is greater than equilibrium and it would not be in his/her self interest to be on either of the decisions. Player 2, moving away also doesn't give the highest payoff. Thus $\{B_1B_2\}$is the Nash equilibrium. Please be mindful that, not every Nash equilibrium is dominant strategy equilibrium but every dominant strategy equilibrium is a dominant strategy.

7.1.2 **MIXED STRATEGY**

lets look at the battle of sexes example. The story goes that a wife (player 1) and husband (player 2) would like to meet each other for an evening out. They can go either to the ballet or to a boxing match. Both prefer to spend time together than apart. Conditional on being together, the wife prefers ballet and the husband prefers boxing.

		Player 2 (Husband)	
		Ballet	Boxing
Player 1 (Wife)	Ballet	2, 1	0, 0
	Boxing	0, 0	1, 2

if the wife chooses Ballet, the husband best response is to choose ballet. If the husband chooses boxing, the wifes best response is to choose boxing. Choosing {ballet,boxing} or {boxing, ballet} does not get the highest payoff. The game has two Nash equilibrium {ballet,ballet} and {boxing, boxing}

we study **mixed strategies**, which have the player randomly select from several possible actions. In mixed strategy, a player chooses their strategy with a probability attached. On the contrary, strategies that are chosen with certainty are called **pure strategies.** In our example, we say we flip a coin and then attend the ballet if and only if the coin comes up heads, and attend boxing match if a tail shows up, yielding a 50–50 chance of showing up at either event.

Let's say, the wife will choose ballet with a probability w and choose boxing with a probability 1-w. the husband will choose Ballet with probability h and choose boxing with probability 1-h. this implies we calculate the expected payoff for each player.

The probability, for example (boxing, ballet)—that is, the wife plays boxing and the husband plays ballet is equals to (1-w)*(h).

The wife's expected payoff for playing ballet with probability w is

$$E(U_1\{ballet\}) = wh * U_1\{ballet, ballet\} + w(1-h) * U_1\{ballet, boxing\}$$
$$= 2hw + w(1-h)0$$
$$= 2hw$$

The wife's expected payoff for playing boxing with probability (1-w) is

$$E(U_1\{boxing\}) = (1-w)h * U_1\{boxing, ballet\} + (1-w)(1-h) * U_1\{boxing, boxing\}$$
$$= (1-w)h(0) + (1-w)(1-h)(1)$$
$$= (1-w)(1-h)$$

The wife's expected payoff if she plays the pure strategy of going to ballet [the same as the mixed strategy (1, 0)] and the husband continues to play the mixed strategy (h, 1-h).
Now there are only two relevant outcomes, given by the two boxes in the row in which the wife plays ballet. The probabilities of the two outcomes are given by the probabilities in the husband's mixed strategy. Therefore,

$$E(U_1\{ballet\}) = h * U_1\{ballet, ballet\} + (1-h) * U_1\{ballet, boxing\}$$
$$= 2h + (1-h)0$$
$$= 2h$$

The wifes expected payoff for playing boxing is

$$E(U_1\{boxing\}) = h * U_1\{boxing, ballet\} + (1-h) * U_1\{boxing, boxing\}$$
$$= h * 0 + (1-h) * 1$$
$$= (1-h)$$

Suppose that $E(U_1\{ballet\}) > E(U_1\{boxing\})$, then wife should play ballet with certainty (w=1)to maximise her payoff. If $E(U_1\{boxing\}) > E(U_1\{ballet\})$, then she should play boxing

with certainty (w=0) to maximise payoff. This means we do not have a mixed strategy equilibrium.

So if the wife is going to play a mixed strategy in equilibrium it must be that she is indifferent between the two strategies. How does such indifference come about? This is down to the husband's strategy choice. The husband's choice of h must be such that the wife is indifferent between playing ballet or boxing. In other words, in equilibrium h must be such that

$E(U_1\{boxing\}) = E(U_1\{ballet\})$,i.e. we have:

$$E(U_1\{ballet\}) = E(U_1\{boxing\})$$
$$2h = 1 - h$$
$$h = \frac{1}{3}$$

If the husband chooses h=1/3, then he must be indifferent between ballet and boxing. This indifference can be done by the wife picking w that makes the husband indifferent.

$$E(U_2\{ballet\}) = E(U_2\{boxing\})$$
$$w*1 + (1-w)*0 = w*0 + (1-w)*2$$
$$w = 2(1-w)$$
$$w = \frac{2}{3}$$

The mixed strategy equilibrium is that the wife plays ballet with probability 2/3 and plays boxing with probability 1/3. The husband plays ballet with probability 1/3 and plays boxing with probability 2/3. We now draw the graph

Wife's best response is such that

$$h > \frac{1}{3}, w = 1$$
$$h = \frac{1}{3}, 0 < w < 1$$
$$h < \frac{1}{3}, w = 0$$

The husbands best response is such that

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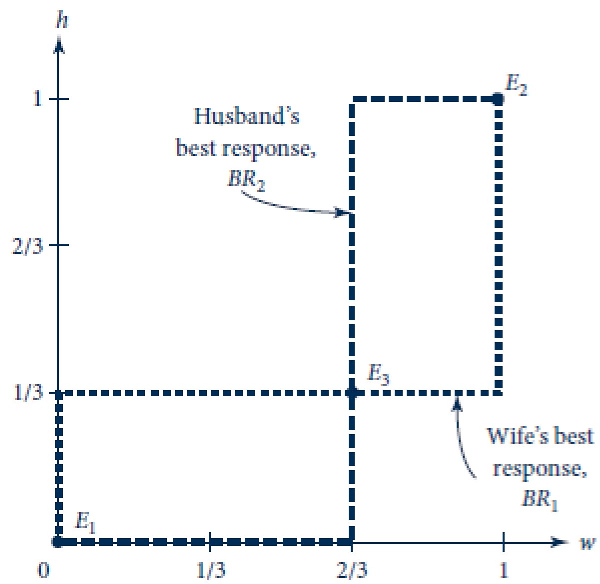
$$w > \frac{2}{3}, h = 1$$
$$w = \frac{2}{3}, 0 < h < 1$$
$$w < \frac{2}{3}, h = 0$$

The graph shows their best response function and thre equilibriums.E_1 is when both h=w=0. They are both playing boxing. E_2 is when h=w=1, both are playing ballet.E_3 is the mixed strategy equilibrium.



Sequential games

Sequential games differ from the simultaneous games we have considered thus far in that a player who moves later in the game can observe how others have played up to that moment. The player can use this information to form more sophisticated strategies than simply choosing an action; the player's strategy can be a contingent plan with the action played depending on what the other players have done.(Nicholson & Snyder, P268)

In sequential games one player moves first while the other observes and moves later.

In the battle of the sexes game, the wife makes the first move while the husband observes and moves later. The wife has two set of action to take its either ballet or boxing. The husband has to decide on;

1. To always play ballet regardless of what the wife picks
2. To always to do the opposite to what the wife decides

3. To always play what the wife plays.
4. To always play boxing

We list the husband set of strategies

Contingent Strategy	Written in Conditional Format
Always go to the ballet	(ballet | ballet, ballet | boxing)
Follow his wife	(ballet | ballet, boxing | boxing)
Do the opposite	(boxing | ballet, ballet | boxing)
Always go to boxing	(boxing | ballet, boxing | boxing)

We now express in the normal form game we have;

		Husband			
		(Ballet | Ballet Ballet | Boxing)	(Ballet | Ballet Boxing | Boxing)	(Boxing | Ballet Ballet | Boxing)	(Boxing | Ballet Boxing | Boxing)
Wife	Ballet	2, 1	2, 1	0, 0	0, 0
	Boxing	0, 0	1, 2	0, 0	1, 2

From the table above we can get the 3 Nash equilibrium to be

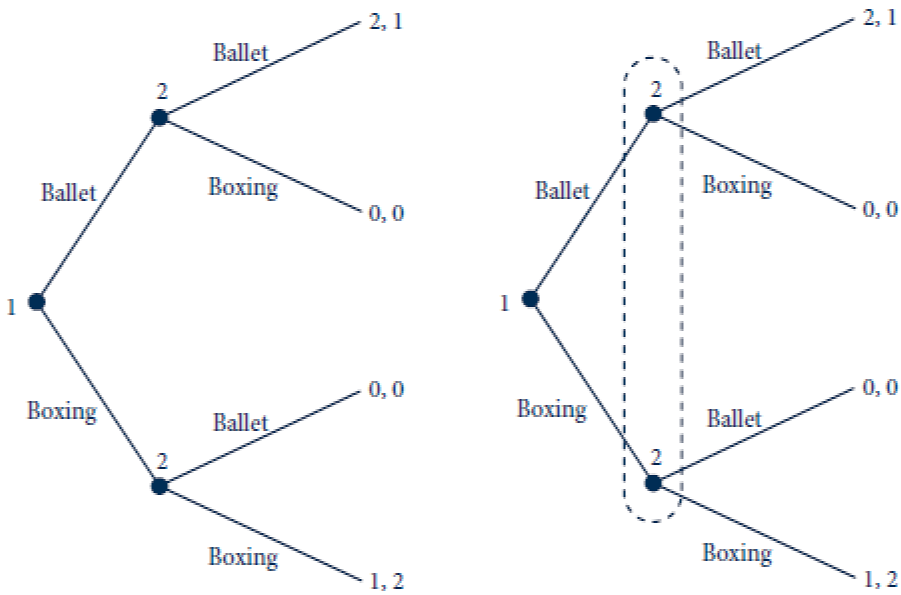
If the wife plays ballet, husband plays $(ballet \,|\, ballet, ballet \,|\, boxing)$

If the wife plays ballet, husband plays $(ballet \,|\, ballet, boxing \,|\, boxing)$

If wife plays boxing, husband play $(boxing \,|\, ballet, boxing \,|\, boxing)$

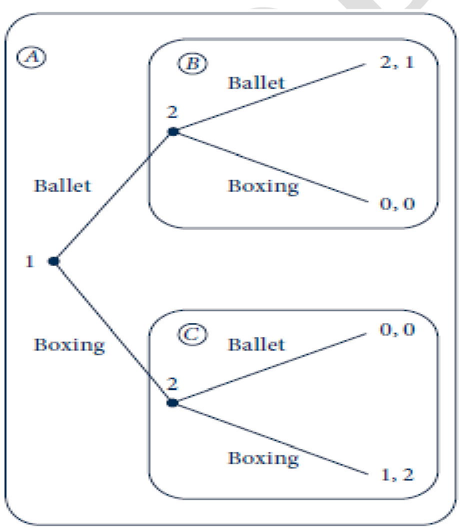
The husband can make a threat to always play boxing and this threat has a higher payoff. The threat is sufficient to make her not choose ballet but it is an empty threat because if she is the first to choose and chooses ballet, he will not choose boxing.

We will also express this in an extensive game. The graph below shows the difference between an extensive form in a simultaneous and sequential game. The simultaneous game has a oval around player twos decision nodes implying that player two has no information on what player one has decided. Both of them know what the other player decides. For sequential game we remove the oval, this is because player two has information on what player one has decided.



(a) Sequential version (b) Simultaneous version

To find a Nash equilibrium in sequential games we use the concept of subgame-perfect equilibrium. Subgame-perfect equilibrium is a refinement that rules out empty threats by requiring strategies to be rational even for contingencies that do not arise in equilibrium. A subgame is a part of the extensive form beginning with a decision node and including everything that branches out to the right of it. We have three decision nodes meaning we have three subgames, the entire game itself and the two decision nodes for player 2.

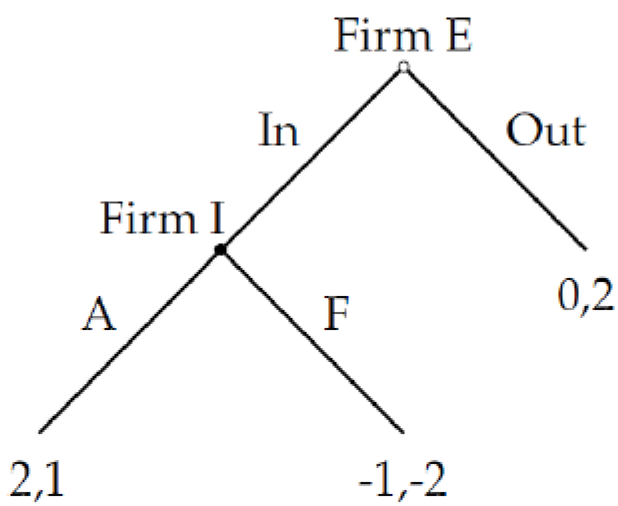


We start with subgame B, the husbands decision when the wife has chosen ballet. He has to choose ballet or boxing and ballet gives a higher pay off than boxing thus he chooses ballet.this

ia anash equilibrium in this subgame. We move to subgame C when the wife chooses boxing, the husband chooses boxing because it gives a higher payoff. This is a nash equilibrium for this subgame. Subgame A has two nash equilibrium ballet,ballet and boxing boxing. From the normal form we had three Nash equilibriums but $(boxing|ballet, boxing|boxing)$ is not a Subgame.

A shortcut for finding the subgame-perfect equilibrium directly is to use backward induction, the process of solving for equilibrium by working backward from the end of the game to the beginning.

For example we have one firm in the market and another one wants to enter the market. The incumbent firm threatens to fight if the new firm enters.so firm E (the entrant) is the one who moves first then the incumbent retaliates. Below is the extensive form game

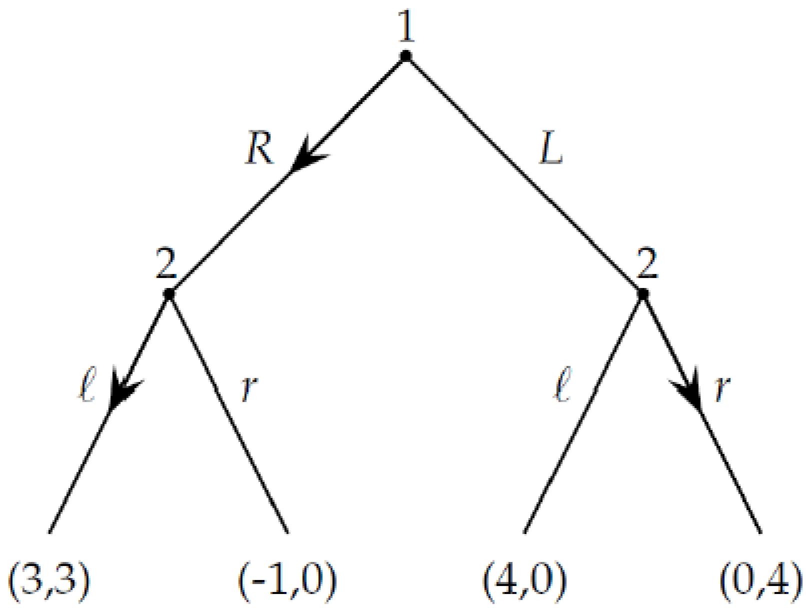


In this game we have two subgame; the entire game and at firm I's decision node. to use backward induction we start from Firm I's decision node, the actions are fight or accommodate. The subgame Nash equilibrium is accommodate if the entrant enters the market. Firm E's action is to enter or stay out. Knowing that firm I will not fight, Firm I will choose to enter. The threat to fight is not credible because the incumbent have zero payoff when he fights. Thus In,A is a subgame perfect nash equilibrium.

A strategy combination is a subgame perfect Nash equilibrium (SPNE) if: it is a Nash equilibrium of the whole game and it induces a Nash equilibrium in every subgame.

It should be clear from the definition that the set of subgame perfect equilibria is a refinement of the set of Nash equilibria.

Another example is given below



We have three subgames. The list of player 2's strategies are {l|L, l|R},{r|L,r|R}, {l|R,r|L),{l|L,r|R} . we start with the subgame for player 2 on the left, player 2 chooses l. in the subgame on the right, player 2 chooses r. player one has two options to pick from (3,3) and (0,4), player one chooses right (3,3). The subgame perfect Nash equilibrium is **{R,** {l|R,r|L)}

Repeated Games

All this while, we have been looking at a game that is played only once. In this section we are looking at games that are played over and over again. The prisoners dilemma game, the equilibrium in one play of the stage game may be worse for all players than some other, more cooperative, outcome. Repeated play of the stage game opens up the possibility of cooperation in equilibrium. Players can adopt trigger strategies, whereby they continue to cooperate as long as all have cooperated up to that point but revert to playing the Nash equilibrium if anyone deviates from cooperation.

In infinitely repeated games we have to add up payoffs from different periods this means we need to discount them to present value. We let the period be T and δ be the discount factor (

$\delta = \dfrac{1}{(1+r)}$ and $0<\delta<1$

Suppose both players use the following specific trigger strategy in the Prisoners' Dilemma: Continue being silent if no one has deviated; confess forever afterward if anyone has deviated to confess in the past. The present value for keeping silent forever is

$$PV = 1 + \delta + \delta^2 + \delta^3 + + + +$$

$$PV = \frac{1}{1-\delta}$$

If in period t one deviates then from period t+1 onwards they all play confess forever. So starting from period t, the present value is

$$PV = 0 + 2\delta + 2\delta^2 + 2\delta^3 + + + +$$

$$PV = \frac{2\delta}{1-\delta}$$

To ensure that deviating is not considered at any point, the present value for not deviating should be greater than present value for deviating, thus

$$\frac{1}{1-\delta} \geq \frac{2\delta}{1-\delta}$$

$$\delta \geq \frac{1}{2}$$

Cooperation can be beneficial if the game is played for a good number of times, for as long as δ is large.

8.7 ACTIVITIES

1. Consider the strategic form game below with two players, 1 and 2. Solve the game by iteratively eliminating dominated strategies.

		Player 2		
		A_2	B_2	C_2
Player 1	A_1	3, 3	−1, 4	0, 5
	B_1	2, 1	3, 2	−1, 0
	C_1	−1, 0	0, 1	1, 0

2.

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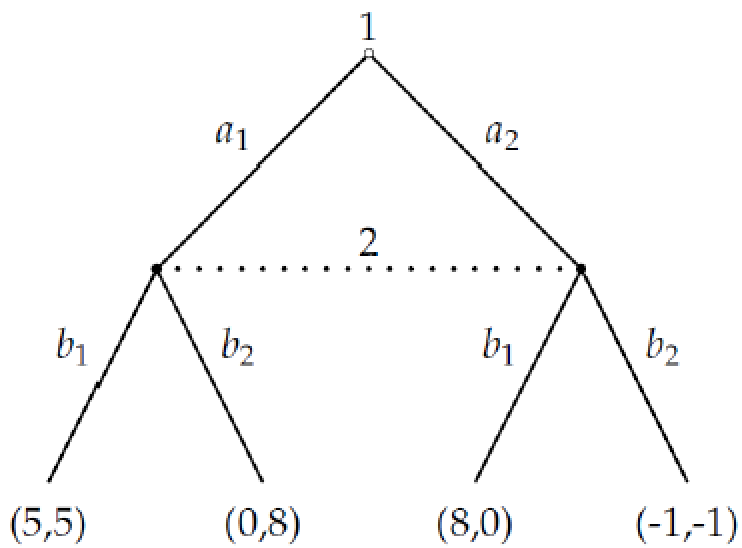

(a) Write down the actions and strategies for each player.

(b) Identify the pure and mixed strategy Nash equilibria.

(c) Identify the pure and mixed strategy subgame perfect Nash equilibria.

8.8 SUMMARY

We have looked at;

1. A game of incomplete information is a situation in which some players must make a move but is unable to observe an earlier or simultaneous move of another player
2. A game with complete information is a situation in which players are aware of or can observe an earlier or simultaneous move of another player
3. A dominant strategy is a strategy that works at least as well as any other one no matter what any other player does.
4. When a player randomizes over hisor her choice of action to keep rivals guessing, the player is said to follow a mixed strategy
5. When players play the same game within a game again and again, the overall game is called repeated game

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9.0 UNIT EIGHT: OLIGOPOLY

9.1 INTRODUCTION

In this unit we look at how agents strategize in making their decision when they know about another agents strategy. In game theory, our analysis is playing a game and your interest is in checking what your opponents' next move is so that you know your move. In oligopoly we apply the technic of game theory in a market structure where every firm needs to strategize based on their assumption or full knowledge of what the other firm decides on producing to maximize profits.

9.2 AIM

The aim of this unit is to introduce you to the analysis of the interaction of firms when they compete in quantity as well as in prices. We introduce the concept of Cournot, Stackelberg and Betrand Nash equilibrium..

9.3 OBJECTIVES

At the end of this unit you should be able to do the following

1. derive the Nash equilibrium in a Cournot game
2. analyse collusion in a Cournot game
3. analyse Stackelberg leadership
4. derive the Nash equilibrium in a Bertrand game
5. derive the Nash equilibrium in a Bertrand game with differentiated products
6. derive the equilibrium in the game of sequential price-setting with differentiated products.

9.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

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9.5 REFLECTION

imagine two firms playing chess? What do they base theirdecision on? Profit or output?

9.6. ESSENTIAL READINGS

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 15

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing

Cournot Nash equilibrium

The characteristics of an oligopoly is

1. sellers are price makers and each firm recognises that its actions have a noticeable effect on the prices that other firms can receive for their output

2. sellers behave strategically. Each firm realizes that its privacy policy can affect the actions of other firms in the market

3. condition on entry range from completely blocked to perfectly free.

4. There are few large firms. Each firm is a significant part of the market and recognise mutual interdependence.

5. Products range from perfect substitutes to products that are highly differentiated.

6. The market incompases well informed and poorly informed customers A cournot model is an application of the simultaneous move game. Firms will make a decision on quantity simultaneous. They will have to think of the best response to what output the other firm might

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produce. Each firm cares only about its own profit, and I it can raise that profit by increasing its output at the expense of its rival, it will do so.

Let s consider a case of two firms in a market with market demand P = a –bQ , where Q is the total summation of the two firms output. $Q = q_1 + q_2$. Marginal cost is c. We start by stating the profit function for the two firms them derive with respect to qi . Firm 1s profit is given; We have gotten firm

$$\Pi_1(q_1, q_2) = (p - c)q_1 = (a - bQ - c)q_1 = (a - bq_1 - bq_2 - c)q_1.$$

We maximise the profit function by taking the first derivative with rest to q1.we have

$$q_1 = \frac{a-c}{2b} - \frac{q_2}{2}.$$

This is firm ones reaction function.

We make firm twos profit function

$$\pi_2(q_1 q_2) = (p-c)q_2 = (a-bQ-c)q_2 = (a-bq_1-bq_2-c)q_2$$

Differentiate the profit function with respect to q2,we have firm twos reaction function

$$q_2 = \frac{a-c}{2b} - \frac{q_1}{2}$$

To solve the two equations, we use simultaneous equation method

$$q_2 = \frac{a-c}{2b} - \frac{q_1}{2} = \frac{a-c}{2b} - \frac{1}{2}\left(\frac{a-c}{2b} - \frac{q_2}{2}\right)$$

$$q_2 = \frac{a-c}{4b} + \frac{q_2}{4}$$

$$\frac{3}{4}q_2 = \frac{a-c}{4b}$$

$$q_2 = \frac{a-c}{3b}$$

$$q_1 = \frac{a-c}{2b} - \frac{q_2}{2} = \frac{a-c}{2b} - \frac{1}{2}\left(\frac{a-c}{2b} - \frac{q_1}{2}\right)$$

$$q_1 = \frac{a-c}{4b} + \frac{q_1}{4}$$

$$\frac{3}{4}q_1 = \frac{a-c}{4b}$$

$$q_1 = \frac{a-c}{3b}$$

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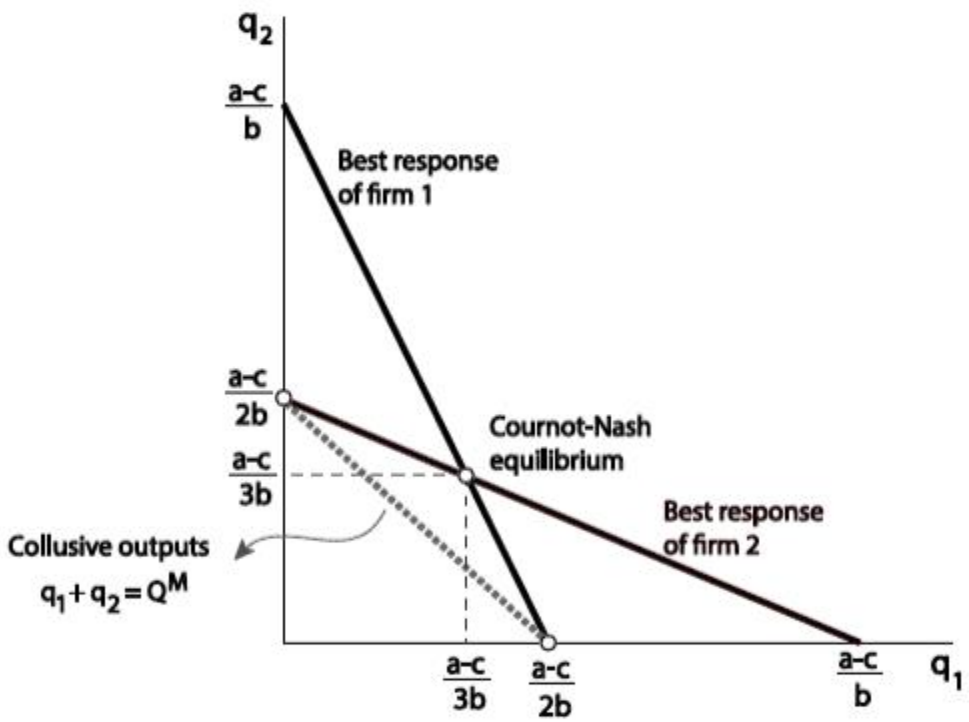
The equilibrium price is the market is $p^{*} = a - 2b \times \frac{a-c}{3b} = \frac{3a}{3} - \frac{2a}{3} + \frac{2c}{3} = \frac{1}{3}a + \frac{2}{3}c.$

With the given quantities and price we now calculate the profit for each firm, we have $\Pi^{D} = \left(\frac{1}{3}a + \frac{2}{3}c - c\right)\frac{a-c}{3b} = \frac{(a-c)}{3}\frac{a-c}{3b} = \frac{(a-c)^2}{9b}.$

The graph below shows the best response function and the Nash equilibrium. To plot this we use the reaction function for firm 1 and firm2. Where the two reaction function meet or cross is the Nash equilibrium



We supposed that both firms have a marginal cost c, now we let the firm have different costs (C_1,C_2) . We use the same method of maximising profit but cautiously put C_1 for firm 1 and C_2 form firm 2. We get reaction functions

$$q_1 = \frac{a - c_1}{2b} - \frac{q_2}{2}$$

$$q_2 = \frac{a - c_2}{2b} - \frac{q_1}{2}.$$

Solving this system of equation by substitution we have

$$q_1 = \frac{a - 2c_1 + c_2}{3b}$$

$$q_2 = \frac{a - 2c_2 + c_1}{3b}$$

COLLUSION

We suppose the two firms collude by forming a cartel where they operate like a monopoly, share the output to produce and profits. The monopoly profit is given

$$\Pi^M(Q^M) = (a - bQ^M - c)Q^M.$$

The first-order condition for a maximum is $\partial \Pi^M / \partial Q^M = 0$ which implies:

$$Q^M = \frac{a - c}{2b}.$$

The market price is:

$$p^M = a - b \times \frac{a - c}{2b} = \frac{a + c}{2}$$

The total profit is:

$$\Pi^M = \left(\frac{a + c}{2} - c\right)\frac{a - c}{2b} = \frac{(a - c)^2}{4b}$$

Monopoly output is lower than the market output before collusion; however its price and profit are higher than when they don't collude. This implies that collusion is beneficial but if it is a once of game, the firms will cheat thus they will never collude. For them to collude they need to play a repeated game and have a trigger strategy. Play the monopoly output but id one firm cheats at one point always play the best response output. We will have profits from different time

periods thus we need to discount the profits to present value. $Q^D = q_1 + q_2$ is the cournot Nash output and $\pi^D = \pi(Q^D)$ is the profit for the cournot output. Q_{Dev} is the output a firm will produce when it deviates from collusion and $\pi_{dev} = \pi(Q_{Dev})$ is the profit from deviating. $Q^M = \frac{Q^M}{2} \times 2$ is the total monopoly output firms will agree to produce. The trigger strategy is

1. Produce $\frac{Q^M}{2}$ and continue producing if no one deviates

2. Produce $\frac{a-c}{3b}$ if one firm deviates at any

If no one deviates the profit is

$$\pi_i(Q_M/2) + \delta\pi_i(Q_M/2) + \delta^2\pi_i(Q_M/2) + \cdots = \frac{1}{1-\delta}\,\pi_i(Q_M/2)$$

If at one point one firm deviates the profit is

$$\pi_i(Q_{\text{Dev}}) + \delta\pi_i(Q^D) + \delta^2\pi_i(Q^D) + \cdots = \pi_i(Q_{\text{Dev}}) + \frac{\delta}{1-\delta}\,\pi_i(Q^D)$$

Where δ is the discount factor. To make collusion profitable or rather to make a firm not to have the incentive to cheat the present value for deviating should be less that the present value for not deviating

$$\frac{1}{1-\delta}\,\pi_i(Q_M/2) \geqslant \pi_i(Q_{\text{Dev}}) + \frac{\delta}{1-\delta}\,\pi_i(Q^D)$$

Working out δ gives

$$\delta \geqslant \frac{\pi_i(Q_{\text{Dev}}) - \pi_i(Q_M/2)}{\pi_i(Q_{\text{Dev}}) - \pi_i(Q^D)}.$$

For a firm not to cheat δ has to be greater than the ratio. The interest rates have to be low, implying that firms are patient to wait for profits in longer periods. If δ is less than the ratio,

firms will cheat and collusion cannot be sustained. Interest rates are high and firms will not be patient to wait for profits in longer periods. Lets look at the general case when we have more than two firms in the market.

$$p = a - b(q_1 + \cdots + q_n) = a - b(q_i + Q_{-i})$$

Profit for firm i is given as ;

$$\Pi_i(q_i, Q_{-i}) = (a - b(q_i + Q_{-i}) - c)q_i$$

Differentiate with respect to qi and equate to zero we get;

$$q_i = \frac{a - bQ_{-i} - c}{2b}$$

Let $q_1 = q_2 = q_3 == q_n$ then $Q_{-i} = (n-1)q$

$$q = \frac{a - (n-1)bq - c}{2b}$$

$$q^* = \frac{a - c}{b(n+1)}$$

Total ouput is the summation of of all firms output

$$Q = \sum_{i=1}^{n} \frac{a-c}{b(n+1)}$$

$$Q = \frac{n(a-c)}{b(n+1)}$$

Stalkerberg

A stackelberg model is one that deals with sequential game theory. One firm will set the quantity first and the other firm will follow. This is seqeuntial quantity setting. The follower will also

strategy to be on his best response function. Firm 1 knowing that firm 2 is on his response function, will maximise profit taking into consideration the response function for the follower firm

The followrs profit is

$$q_2^* = \frac{a-c}{2b} - \frac{q_1}{2}.$$

$$\begin{aligned}
\Pi_1(q_1, q_2) &= (a - bq_1 - bq_2^* - c)q_1 \\
&= \left(a - bq_1 - \frac{a-c}{2} + \frac{bq_1}{2} - c\right) q_1 \\
&= \left(\frac{a-c}{2} - \frac{bq_1}{2}\right) q_1.
\end{aligned}$$

$$q_1^* = \frac{a-c}{2b}.$$

Replace in firm 2 reaction function we get;

$$q_2^* = \frac{a-c}{4b}.$$

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The leader chooses a high output than the follower. The total output is

$$Q^{**} = \frac{3}{4}\frac{(a-c)}{b}$$

We replace in the demand function to get the price

$$p^{**} = \frac{1}{4}a + \frac{3}{4}c$$

The leader profit is thus calculated as;

$$\Pi_L^S = (p^{**} - c)\,\frac{a-c}{2b} = \frac{(a-c)^2}{8b}$$

The followers profit is

$$\Pi_F^S = \frac{(a-c)^2}{16b}.$$

The leader has a greater profit than the follower because he chooses a higher output. We make a comparison between, perfect competition, cournot monopoly and stackelberg.

	Perfect competition	**Cournot duopoly**	**monopoly**	**stackelberg**
Market quantity	$\frac{a-c}{b}$	$\frac{2(a-c)}{3b}$	$\frac{a-c}{2b}$	$\frac{3(a-c)}{4b}$
price	c	$\frac{a-2c}{3b}$	$\frac{a-c}{2b}$	$\frac{a-3c}{4b}$
Industry profit	$\frac{(a-c)^2}{2b}$	$2\frac{(a-c)^2}{9b}$	$\frac{(a-c)^2}{4b}$	$\frac{3(a-c)^2}{16b}$

BETRAND

in a Bertrand model we are looking at price setting. We assume firms are producing identical products. The only Nash equilibrium is to set price equal to marginal cost. This is because if a firm set price below marginal cost it gets losses thus no rational firm would produce at a point where price is less than marginal cost. Setting price above marginal cost, no one follows suit thus your goods are expensive and you lose market share. Thus P=MC is the only nash equilibrium

BETRAND WITH PRODUCT DIFFERENTIATION

With identical products, demanders were assumed to be indifferent about which firm's output they bought; hence they shop at the lowest-price firm, leading to the law of one price. The law of one price no longer holds if demanders strictly prefer one supplier to another at equal prices. We have two firm with their demand function, calculate equilibrium price and output

$$q_1 = \alpha - P_1 + P_2 \qquad q_2 = \alpha - P_2 + P_1.$$

$$\Pi_1 = (P_1 - c)(\alpha - P_1 + P_2)$$

Derive with respect to p1and equate to zero

$$(\alpha - P_1 + P_2) - (P_1 - c) = 0.$$

$$P_1 = \frac{\alpha + c + P_2}{2}$$

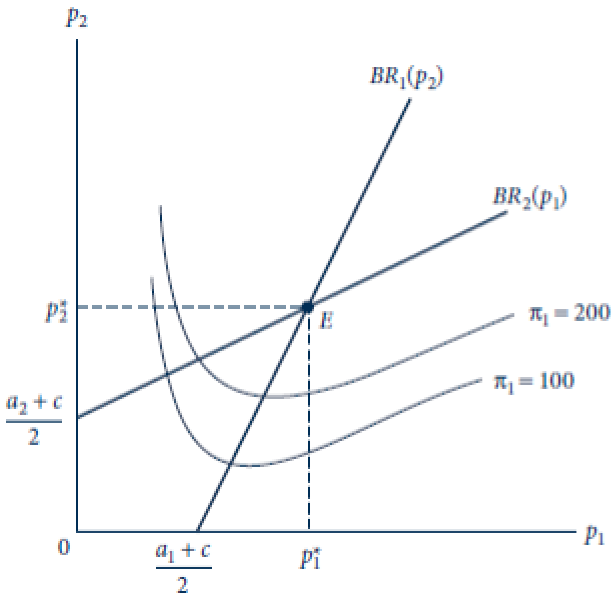
Thisis firm 1 reactionfunction.and firm2is

$$P_2 = \frac{a + c + P_1}{2}$$

Solving for p1 and p2 we get

$$P^* = \alpha + c.$$

This is the betrand nash equilibrium price The profit is a^2 We show the reaction function on the graph



The intersection of the reaction function is the nash equilibrium

sequential pricing

Firm one is the first mover then firm 2 is the follower. Firm 2 is on its reaction function while firm 1 has to maximize its profit given firm2s reaction function.

$$\Pi_1 = (P_1 - c)q_1 = (P_1 - c)\left(\alpha - P_1 + \left(\frac{\alpha + c + P_1}{2}\right)\right)$$

Maximizing and setting to zero we get

$$P_1^* = c + \frac{3\alpha}{2}.$$

$$P_2^* = c + \frac{5\alpha}{4}.$$

Which firm has the highest profit

$$\Pi_1 = (P_1 - c)(\alpha - P_1 + P_2) = \frac{3\alpha}{2}\left(\alpha - \frac{3\alpha}{2} + \frac{5\alpha}{4}\right) = \frac{9\alpha^2}{8}$$

$$\Pi_2 = \frac{25\alpha^2}{16}.$$

$\Pi_2 > \Pi_1$. Firm two has the highest profit because it charges the lowest price.

8.7 ACTIVITIES

1. The (inverse) market demand for a good is P = a - bQ, and all firms have a constant marginal cost c.

(a) Derive the perfect competition market quantity, price, industry profit, consumer surplus and total surplus.

(b) Derive the monopoly market quantity, price, industry profit, consumer surplus and total surplus.

(c) Assuming that there are two firms that compete by setting quantities simultaneously, derive the Cournot duopoly market quantity, price, industry profit, consumer surplus and total surplus.

2. suppose that the market demand curve for some airline is Q=1000-pand each airline has a constant marginal cost of 100.

a. what is the equilibrium price and output when there are two airlines in the market?

b. what are equilibrium prices and output when there are three airlines in the market?

8.8 SUMMARY

- Firms in an oligopoly market worry about one another's actions
- Firms would like to collude , but their ability to do so is typically limited by the need to rely on self-enforcing agreements
- Firms compete by choosing output
- Firms compete by choosing prices

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10.0 UNIT NINE: ASSYMETRIC INFORMATION

10.1 INTRODUCTION

In this unit we look at how much information two agents in a transaction might have. In many transactions, people involved will have different amounts of information. An example is the employer-employee relationship, insurance company-customer relationship. In all these example both parties have different sets of information. An agent with better information takes advantage of the others lack of information. This creates problems of adverse selection and moral hazard.

In this chapter we will analyse the problems asymmetric information and how we can alleviate them. We specify a model to capture an effort choice problem and suggest contractual solutions.

10.2 AIM

The aim of this unit is to introduce you to problems of adverse selection and moral hazard. How we can minimise the problems and their interaction in determining the optimal form of incentive contracts offered by the principal to the agent.

10.3 OBJECTIVES

At the end of this unit you should be able to do the following

- explain the different types of asymmetric information problems
- explain how the scope of enquiry of economics is expanded by considering information asymmetry problems
- explain the types of problems that arise under adverse selection and moral harzard
- analyse the problem of price discrimination by a monopolist under adverse selection
- Analyse separating and pooling equilibria in the signalling model of education.

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- explain the problem of effort choice and analyse effort choice in a principal-agent model
- Explain the trade-off between risk-sharing and effort incentives in the principal-agent model and analyse the optimal risk-sharing arrangement under full asymmetric information.

TIME REQUIRED

Minimum amount of time on the unit is 2 hours

10.5 REFLECTION

Imagine you want to employ an economist for your firm, how would you know that the person who is looking for a job is the most hardworking and how would you know that they will come work hard for you after you employ them?

10.6. ESSENTIAL READINGS

Nicholson, W. and Snyder, C.M (2011) *Microeconomic Theory: basic principles and extensions* (11th edition). Australia: South Western College Publishing. Chapter 18

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 17

10.7 ADVERSE SELECTION

Asymmetric information is a situation in which one side of an economic relationship has better information than the other. When you buy a car a used car, the person selling it knows a lot more about whether it is a lemon (poor quality car) than you do. When a firm hires a new employee,

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that worker has a much better idea about his ability than the firm. In many instances of asymmetric information, the less informed side knows that the other side has more information. Given this awareness, the less informed side of the deal may be able to make inferences from the informed sides action.

There are two types of information that an agent might lack but desire. Firstly, one knows some characteristics that the other does not have, e.g the seller of the used car has a better idea abouts its reliability than the buyer. When one side of the transaction knows something about itself (the product) that the other does not, we say it's a situation of *Hidden Characteristics.* Secondly, when one side of the transaction can take an action that affects the other side but which the other side cannot directly observe, is a situation of *hidden actions*. An example of hidden actions is when a firm hires a new employee, the firm wants the employee to work hard but it may be difficult to observe whether the employee sometimes shirks.

AKERLOF's model of market for lemons

We examine the effects of hidden characteristics on the operation and performance of the market using George A. Akerlof's modl published in 1970.
(George A. Akerlof (1970) `The market for `lemons': quality uncertainty and the market mechanism', Quarterly Journal of Economics, volume 84, pages 488{500.)

Consider a market for used cars. There are some low quality cars and some high quality cars. Potential sellers have a car each, and there are many more buyers than possible sellers in the market. A high quality car rarely breaks down. A low quality car provides a poorer ride quality over longer journeys and also breaks down with higher probability compared to high quality cars.
A seller values a high quality car at 1,000 and a low quality car at 300. A buyer values a high quality car at 1,300 and a low quality car at 400. All agents are risk-neutral.
Assume that the sellers get the entire surplus from trade.

Market failure
Suppose quality is observable to sellers but not to buyers. Buyers only know that a fraction of 1/2 of the cars in the market are high quality and the rest are low quality.
Let us analyse the market outcome in this case.

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The average value of buyers is 850. If all cars are in the market, this is the most buyers would pay. But at this price high quality cars withdraw. So only low quality cars would sell. Knowing this, buyers would be willing to pay at most 400. Assuming sellers get the entire surplus, the market price is 400 and only low quality cars exchange hands. The market outcome is not efficient since the gains from trading high quality cars are not exploited.

Separation through refunds

Suppose low quality cars break down with probability 0.8, and high quality cars break down with probability 0.1. Suppose the sellers have an option of promising a refund of R if the car breaks down.

Let us see if such a policy can lead to a separating equilibrium. In a separating equilibrium, it must be the case that sellers of high quality cars sell at 1,300 and promise a refund of R in the event of a breakdown, while sellers of low quality cars sell at 400 without any refund promise.

For high quality sellers to sell at 1,300 with a refund promise, it must be that they like this better than not selling, which means:

$1300 – 0.1R \geq 1000$

which implies $R \leq 3000$. This constraint is called the participation constraint (PC) of high quality sellers. Also, the low quality sellers must prefer to sell at 400 without a guarantee rather than imitate the high quality sellers (offer a refund of R and sell at 1,300). This implies:

$400 \geq 1300 - 0.8R$

which implies $R \geq 1125$. This is called the incentive compatibility constraint (IC) of low quality sellers. The value of R must be such that the PC of high quality sellers and the IC of low quality sellers are both satisfied. This implies that the range of values of R for which the separating equilibrium holds is $1125 \leq R \leq 3000$.

Forced refunds

Suppose the government decides to force each seller to offer a full refund if the car sold by the seller breaks down. How does this change the market outcome? Is the market outcome efficient?

Note that the maximum possible price in the market is 1,300. But even at a price of 1,300, $0.2 \times 1300 = 260$ is below 300. It follows that low quality sellers would not participate in the market, and only high quality sellers would remain and sell at 1,300.

But this is not efficient as the gain from trade of low quality cars is not realised.

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In other words, forcing sellers to issue a refund destroys the role of a refund policy in separating the two qualities. Since all sellers must issue a refund if the car breaks down, low quality sellers prefer to withdraw from the market, making it impossible to exploit gains from trading low quality cars. Policy choices that are not sensitive to the role of an instrument in providing information to uninformed agents do not necessarily promote efficiency.

A model of price discrimination

Consumers know how much they are willing to pay for a good, but the firm selling to them does not. Consider the problem faced by Zambian airlines. Assume Zambian airlines flies a direct route from Lusaka to Dubai. The airlines' marginal cost of adding passengers to the flight is $120 per passenger. The potential passengers aare a businessman and a tourist. The businessman is willing to pay$500 for the flight but wants to stay for a day only. If he has to stay for more than a day he is willing to pay $250. The tourist on the other hand, is willing to pay $200for a flight and he doesn't care the length of the trip. Neither consumer is willing to pay anything more for the flight.

Zambian airlines dilemma is

1. If it charges $500 per ticket, it will discourage the tourist but would earn them$380=500-120.
2. If it charges $200 per ticket. It attracts the touristand the businessman and earn $160=2(200-120)

When consumers differ in willingness to pay, the seller can increase its profit by charging different prices to different customers. This is price discrimination.

Consumers' willingness to pay is a hidden characteristic which is difficult to get. They can ask consumers how much they are willing to pay or ask if they are going for a business trip or vacation, but this would not be effective. The airline needs to find a signal, which is an indicator of the hidden characteristic. The most effective signal would be the willingness to take a long trip. They can charge a fare of $449 that has no restriction on when it can be used and charge a holiday fare of $200 if you going for a long trip. This is a self-selection device. A consumer's choice tells the airline the type of customer the person is. Whenever the uninformed party (airline) sets up a mechanism for sorting the informed parties (passengers) based on the signals they transmit, the uninformed party is engaging in screening.

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The use of signals is an important phenomenon in the labour markets. Consider a competive labour market where half the workers are low ability and have a marginal revenue product of \$200 per week. The other half are high ability workers with a marginal revenue product of \$400 per week. Scenario one, suppose that ability is observable to everyone, both workers and the firm know the ability of the worker employed. Each worker is paid their marginal revenue product. Scenario two, now suppose ability is not observable, you cannot determine a person's ability by looking at them. The worker is the only agent that knows their ability whether low or high. The firm only knows that there is half chance that an individual is low ability and half chance he/she is high ability. As a result the firm will calculate the expected marginal revenue product which is \$300=0.5(200) + 0.5(400). The firm will pay a weekly wage of \$300.

Comparing the two scenarios the low ability workers are better off when ability is not observable. However, the high ability workers are worse off. High ability workers are hurt due to lack of information and would want to reveal themselves as high performers. They need to send a signal that low ability workers are unwilling to mimic. Attaining more qualification may be a signal. If ability at work and ability in university are closely related, going to university may be costlier for low ability workers than high ability ones. This is because low ability workers will find university to be challenging and have to work harder to keep up with the demands. Therefore, the more education one attains the more income they should get.

Adverse selection arises whenever there is hidden characteristics problem and people on the informed side of the market self-select in a way that is harmful to the uninformed side.

10.8 MORAL HAZARD

Moral hazard is a situation of hidden actions because in such cases the informed side may take wrong actions. Suppose you own a store and you want a sales agent. You want the employee to do a good job serving customers while you are out of the store. But you cannot be sure that he/she will work hard; he/she may simply tell customers to go away so that he/she rests. This is a principal-agent relationship. The principal hires the second party(agent) to perform some tasks on his/her behalf. The principal and agent may have different objectives and the principal cannot directly monitor the agents behaviour. Therefore, the

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principal has to worry about the agents actios. In hidden actions, economic relationships have to be designed to transfer information from the informed to the uninformed.this is called signalling. The uninformed party has to make sure that the informed party has the right incentive to take the right action.

Moral hazard and insurance markets.

Hidden actions problems arise in the industry when a policyholder may take unobservable actions that affect the probability that he/she will suffer a loss and file an insurance claim.

A homeowner can reduce the chance of a serious fire by purchasing heat detectors, constantly buying new appliances, replacing wiring in the house and being cautious when using a hot plate. The marginal benefit of increased care is the marginal reduction in expected damages. Therefore, te homeowner purchases care just up to the point where the marginal benefit and marginal cost are equal.

Now suppose the homeowner buys insurance that covers the complete cost of the house and everything in it. Insurance affects the marginal benefit of care from the homeowners perspective. Since the costs of replacing the house are covered by the insurance company, the homeowner doesn't count the reduction in the chance of a fire as a benefit. Since the marginal benefit of care reduces, he/she puts in less care and increases the chance of a fire knowing that the insurance covers everything. Now how foes the insurance company make sure that that the right amount of care is taken by the homeowner?

Co-insurance is a provision in an insurance policy under which the policyholder picks up some percentage of the bill for damages when there is a claim. This is cost sharing. Excess or deductibles is a situation where the policyholder has to pay the initial damages up to some set limit e.g the homeowners insurance policy may not cover the first $1000 damages .

Employer-employee relationship

In chapter two we looked at labour supply, the number of hours in labour an individual is willing to supply. The individual consumes leisure and a composite good, and has to decide how much leisure to consume and how much labour to supply so as to have a composite good. Leisure includes leisure away from the workplace and on the job, such as not working hard as possible. Suppose the individual has to be in the office for 40 hours per week, he can choose the amount of leisure consumed by adjusting the extent he shirks at his job.

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If the effort an individual puts in the job is observable and the employer can see how much he/she is shirking, the employer can tell the employ how hard to work otherwise he would be fired. However the employer face a constraint, that is, restrain the employ from quitting by paying him/her enough. Therefore, the employer must give the employee a combination of shirking and composite good that keeps the employee on his indifference curve.

Suppose that the employer cannot observe effort and shirking. The employer cannot base the employees' compensation directly on the amount he shirks and cannot threaten to fire him for failing to work hard.

If the employer gives a flat salary, the employee has a constant income no matter how much he shirks. To entice the employee to reduce the amount of shirking the employer should give an incentive for hard work. That is compensating an employee when they work hard. Performance based compensation is tying the employee's salary to profitability of the firm.

10.9 ACTIVITY

1. Suppose that 10 employees work together as a team to produce output. It is impossible for the management of their firm to tell how hard anyone employee is working. The management can, however, observe the teams output and thus can tell how hard the employees are working on average. Can you think a performance based compensation scheme that will give the employees the incentive to make efficient shirking decision? Do you see any problem with the scheme?

2. explain why a car manufactures' willingness to offer a resale guarantee for its cars may serve as a signal of their quality.

3. what are the market responses to adverse selection in the insurance market?

What are government response to hidden characteristic and hidden actions?

10.10 SUMMARY

- Whenever one side of a transaction knows something about itself that the other doesn't know, we are dealing with hidden characteristics.
- Whenever one side of the transaction takes actions that the other sides cannot observe, we are dealing with hidden action.

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11.0 UNIT TEN: EXTERNALITY AND PUBLIC GOODS

10.1 INTRODUCTION

In this unit we look at how the presence of externalities and public good affects the competitive markets outcome. In some situations, the utility of an agent is affected by the level of activity of another agent directly. However, the acting agent does not take this externality into account. The result is that the market outcome is inefficient. The individually-optimal level of an activity that generates a negative externality is higher than the socially-optimal level, and that for an activity that generates a positive externality is lower than the socially-optimal level. The invisible hand does not work well in such cases {individual optimisation does not lead to social optimality.

Competitive markets also work poorly in the presence of public goods. However, public goods such as national defence, roads, basic public health, basic education and defence against natural catastrophes are important for any economy. Provision of such goods using receipts from taxes is a crucial role for the government in the economy.

11.2 AIM

The aim of this unit is to introduce to situations in economic theory that does not lead to efficient outcomes. When there is a distortion in the market, the market fails to efficiently allocate resources to give a desired outcome.

11.3 OBJECTIVES

At the end of this unit you should be able to do the following

- explain the concept of externalities and show how externalities lead to market failures
- analyse remedial policies based on taxes or subsidies

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- explain the content of the Coase theorem and analyse the Coasian property rights approach to solving the problem of externalities
- explain the concept of public goods and analyse how private provision leads to an inefficiently low provision of such goods

11.4 TIME REQUIRED

Minimum amount of time on the unit is 2 hours

11.5 REFLECTION

Imagine how much we would pay for the security of national defense if government was to charge us?

11.6. ESSENTIAL READINGS

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.:Irwin/McGraw-Hill) chapter 18

11.7 Distortions

Distortions; A distortion exists whenever society's marginal cost of producing a good does not equal society's marginal benefit from consuming that good.

In general, conditions causing market failure are classified into four categories

- Monopoly power

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- Exists when one firm exert some market power in determining prices

- Externalities

  - An interaction among agents that are not adequately reflected in market prices—effects on agents are external to market. e.g. Air pollution is classic example of an externality Public goods

  - One individual's consumption of a commodity does not decrease ability of another individual to consume it. E.g. Examples are national defense, and street lights Asymmetric information

  - When perfectly competitive assumption of all agents having complete information about commodities offered in market does not hold Incomplete information can exist when cost of verifying information about a commodity may not be universal across all buyers and sellers

For example, sellers of used automobiles may have information about quality of various automobiles that may be difficult (costly) for potential buyers to acquire

  - When there is asymmetry in information buyers may purchase a product in excess of a given quality

Existence of monopoly power, externalities, public goods, and asymmetric information are justification for establishment of governments to provide mechanisms to address resulting market failures

- Governments can regulate firms with objectives of mitigating monopoly power and negative externalities
- Governments can provide for public goods either by direct production or private incentives
- Governments can generate information, aid in its dissemination, and mandate that information be provided in an effort to reduce asymmetric information

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- The more a government must intervene in marketplace to correct these failures. The less dependent will the economy be on freely operating markets

8.7.1 **Externalities and public goods.**

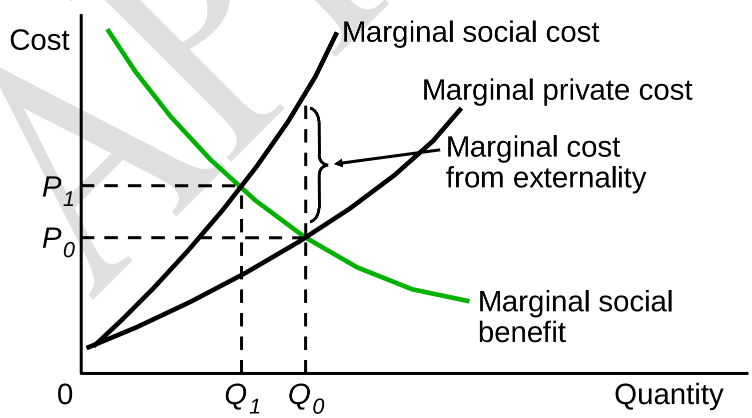
The activities of an individual, society or a firm has an effect on another individual, society or firm is what is called externalities (side effects).externalities can as a result of production and consumption. When externalities are beneficial is called *external benefits***.** When they are hazardous it's called *external cost***.**

Social cost to society for the production of any good is the private cost faced by the firms plus any externalities (positive or negative). *Social benefit* is the private benefit enjoyed by consumers plus any externalities.

External costs of production. (MSC>MSB)

When a chemical firm dumps wastes into the river or pollutes the air, the community bears costs additional to those borne by the firm. MSC>MPC. Marginal social cost are greater than marginal private cost.

The Effect of a Negative Externality



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The firm is maximising profits at price Po and quantity Qo. This is where MSB=MPC. Now there is negative externality to society which makes the, marginal social costs higher than the private costs. The MBC curve is above the MPC. We assume no externalities from consumption, we equate MSB=MSC and we have a socially optimum output Q1 and price P1. The marginal benefit to consumers is the same as the marginal social benefit. Meaning at (Po,Qo) the firm will produce more than what is socially optimum. They are producing more than society's point of view. By producing less, society saves more in social cost than it loses in social benefit. It would make some people better off without making anyone worse off. Producing at Qo is inefficient. The difference between MSC and MPC shows the marginal social loss of producing the last unit of output by expanding output from Q1 to Q0 society losses the triangle area.

This problem arises in a free market economy because no one has legal ownership of the air or rivers and no one can prevent anyone from using them as a dump. Therefore control must be left to the government.

External benefits of production

If for example a timber processing company plants new trees, there is a benefit to society as the trees help reduce carbon dioxide in the atmosphere. The MSC of providing timber is less than the MPC to the company.

The below shows that MSC is below MPC. Qo is what the company is producing. Q1 is what society deems optimum. The firm is producing less than what is socially optimal.

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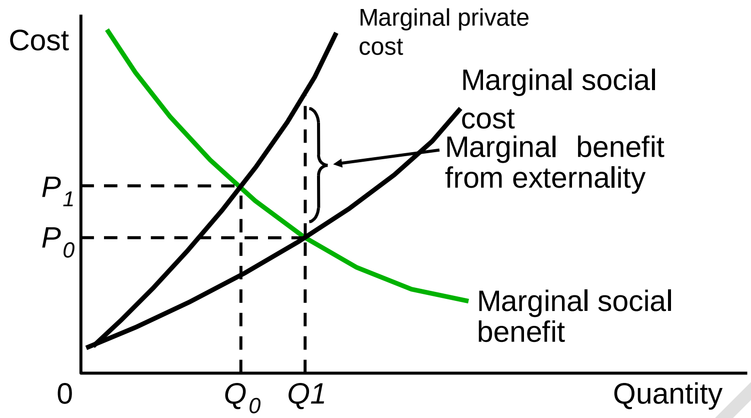
The Effect of a Positive Externality on production



External costs of consumption

Let us consider an individual who buys a car which emits CO_2. The marginal benefit to society will reduce as the motorist travels. The optimum distance travelled by the motorist will be Q1 miles. This is where MPB=MSC/MPC. If the marginal benefit of consuming a good exceeds its price then the consumer will buy ad consume more. If the marginal benefit is less than the price, the consumer gains by consuming less. When people use their cars, other people suffer from the exhaust fumes, the congestion, the noise etc. These negative externalities make the social benefit of using the car less than the marginal private benefits. The MSB is less MPB. Assuming no externalities in production. The socially optimum output is Qo which is less than Q1. Other examples are noise pollution from the radio, cigarretes and

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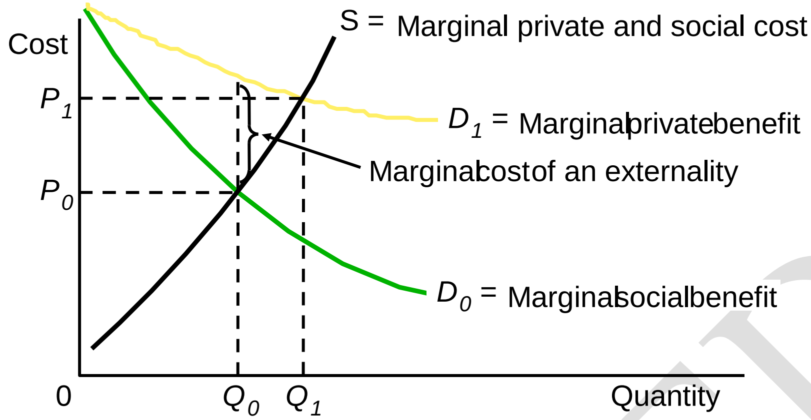
A negative Externality

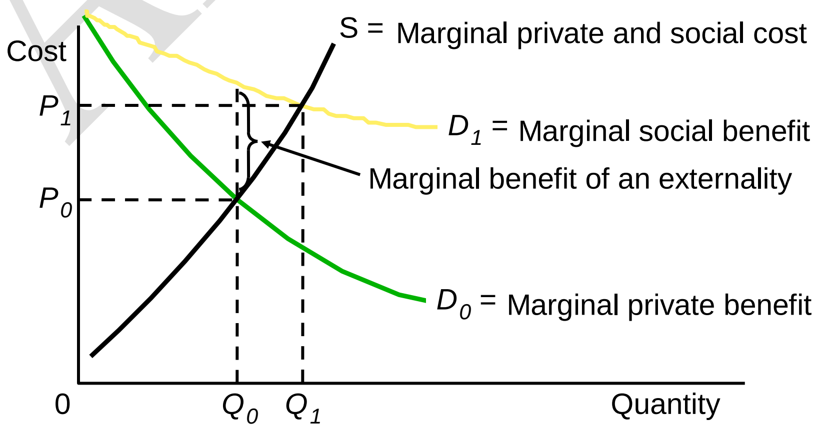


litter.

External benefits of consumption

The figure below shows a beneficial consumption externality. Planting roses in your garden makes your neighbour happy. With no production externality, MPC is both the private and marginal social cost of planting roses. It is the cost of the plant and the opportunity cost of your time. Comparing your our cost and benefit you plant Qo roses. The marginal social benefit exceeds your private benefit. The socially optimum quantity is Q1. Therefore, society could gain the triangle area, the excess of social benefits over social costs, by increasing the quantity of roses from Qo to Q1.

A Positive Externality



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COASE THEOREM

According to Ronald coase, externality problems can be resolved through private negotiations by the affected parties when property rights are clearly established. He says government is not needed to remedy negative or positive externality as long as property rights are clearly defined, the number of people involved is small and the bargaining cost are negligible. However, many externalities involve huge number of people affected, high bargaining costs and community property such as air and water cannot be priced.

Private goods.

Private goods are goods that are produced through the competitive market system. Private goods encompass the full range of goods offered for sale in stores. These are goods people individually buy and consume and private firms can profitably provide because they keep people who do not pay from receiving the benefits.These goods have two characteristics; rivalry and excludability.

- Rivalry in consumption means that when one person buys and consumes a product, it is not available for another person to buy and consume. E.g. buying and consuming a bar of candy.
- Excludability means that sellers can keep people who do not pay for a product from obtaining its benefits. Only people who are willing and able to pay the market price for bottles of water can obtain these drinks.

The demand we have look at in the beginning was demand for a private good. Consumers demand for private goods is expressed by the desire and ability to pay for the product. The demand is an inverse relationship, meaning when the price of a product increases the demand for it will reduce.

Public goods.

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Public goods have the opposite characteristics to private goods. They are 1) non rivalry, 2) excludability. They cannot be provided for by a private firm because of their nature.

- Non rivalry is where the consumption of the good or service by one person will not prevent others from consuming it.
- Non excludability is where it is not possible to provide a good or service to one person without it being available to others. E.g. roads, national defence.

Public goods have larger external benefits relative to private benefits but are unprofitable. No one is willing to pay for a public good. For example paying to build a pavement along your street. This is because the private benefit will be too small compared to the cost and yet social benefit is much more. These two characteristics create a **free rider problem**. Once a producer has provided a public good, everyone including non payers can obtain the benefit. Most people do not voluntarily pay for something they can obtain for free.

EXAMPLE; If I own a farm and build a tarred road to my farm, my neighbours too will benefit from using that road and I cannot prevent them from benefiting, therefore they will have no incentive to pay. This is what is called a free rider problem. Such goods only the government can provide or by subsidising the private firms. Note that not all goods produced by the public sector fall in the category of a public good e.g education and health.

With this problem, the demand for public good is not expressed in the market. With no market demand, there is no potential firm to tap the demand for revenues and profits. If society wants a public good, government will have to provide it. They government can estimate the demand through surveys or public votes, then it can compare the marginal benefit t of an added unit of the good against the govts marginal cost of providing it.

They demand that can be derived from consumers would should their willingness to pay. If a survey was conducted to find out how much each individual would pay for a road to be built, the people would indicate how much they would be willing to pay for an extra unit. But once govt provides the good, because of non-rivalry and non

excludability, they would not be able to pay for it. The only curve that can be derived is a willingness to pay schedule. This curve is different from the demand curve because its shows the price the consumer would be willing to pay for an extra unit of a product to be provided, whereas the demand curve shows us the quantity that would be demanded at each price given.

11.8 ACTIVITY

1. a government has a choice of policy instruments to use to help reduce car pollution. It can either set a minimum petrol mileage efficiently that all cars must achieve or tax petrol. Compare the two policy instruments.

2. in each of the following situations, explain whether the coase theorem would be likely to provide a basis for dealing with externality;

a. the Kafue river receive industrial effluents

b. global warming is a results of carbon dioxide released from coal, oil and wood when burnt

11.9 SUMMARY

- Production externalities occur when actions by ne producer directly affect the production costs of another producer, as when firms pollutes another's water supply.
- Consumption externality mean ones persons decision affects another's consumers utility directly, as when a garden gives pleasure to neighbours.
- Public goods are non rival and non excludable.

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